# OPPORTUNITIES FOR ENGINEERING AND SCIENTIFIC REMOTE COMPUTING SERVICES

INPUT

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INPUT Planning Services for Management

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AUGUST 1983

# OPPORTUNITIES FOR ENGINEERING AND SCIENTIFIC REMOTE COMPUTING SERVICES

## CONTENTS


| | | Page |
|---|---|---|
| I | INTRODUCTION | 1 |
| | A. Purpose And Scope | 1 |
| | B. Definitions | 3 |
| | C. Methodology | 4 |
| II | EXECUTIVE SUMMARY | 7 |
| | A. Opportunities For Engineering/Scientific Remote Computing Services | 8 |
| | B. Engineering/Scientific Marketplace Trends | 10 |
| | C. Per-customer RCS Spending Has Been Shrinking | 12 |
| | D. Most Engineering/Scientific Computing Is Done In-house | 14 |
| | E. The Total RCS Engineering/Scientific Market Will Grow Slowly | 16 |
| | F. Some Applications Will Grow Strongly | 18 |
| | G. Other RCS Applications Will Languish | 20 |
| | H. Some Customer Needs Remain The Same - Others Diminish | 22 |
| | I. INPUT Recommendations | 24 |
| | J. INPUT Recommendations | 26 |
| III | MARKET ANALYSIS AND FORECASTS | 29 |
| | A. Changes In The Marketplace, 1979-1988 | 29 |
| | 1. Technological Changes, 1979-1983 | 29 |
| | 2. Technological Changes, 1983-1988 | 30 |
| | 3. Administrative And Regulatory Changes, 1979-1983 | 31 |
| | 4. Administrative And Regulatory Changes, 1983-1988 | 32 |
| | 5. Business Condition Changes, 1979-1983 | 32 |
| | 6. Business Condition Changes, 1983-1988 | 33 |
| | B. Analysis Of Computing Modes | 33 |
| | 1. Current Spending | 35 |
| | 2. Projected Spending | 38 |
| | 3. Reasons To Choose A Computing Mode | 41 |
| | 4. Three Support Modes | 43 |
| | C. Market Forecasts, 1983-1988 | 45 |
| | 1. Structural Engineering | 45 |
| | 2. Project Management | 45 |
| | 3. Electrical/Electronic Engineering | 45 |
| | 4. Piping | 49 |
| | 5. Graphics/Plotting | 49 |
| | 6. Nuclear Engineering | 49 |

| | | Page |
|---|---|---|
| | 7. Chemical/Processing Engineering | 51 |
| | 8. Statistics And Operations Research | 51 |
| | 9. Other Applications | 51 |
| | 10. Discipline Comparisons | 52 |
| IV | USER NEEDS FOR ENGINEERING/SCIENTIFIC COMPUTING..... | 57 |
| | A. Structural Engineering | 57 |
| | 1. Introduction | 57 |
| | 2. Sources And Uses Of Structural Applications | 58 |
| | 3. Key Applications | 60 |
| | 4. Hardware/Software Needs | 63 |
| | 5. Market Strategy Implications | 64 |
| | B. Civil Engineering | 65 |
| | 1. Introduction | 65 |
| | 2. Sources And Uses Of Civil Engineering Applications | 66 |
| | 3. Key Applications | 68 |
| | 4. Hardware/Software Needs | 70 |
| | 5. Market Strategy Implications | 71 |
| | C. Nuclear Engineering | 72 |
| | 1. Introduction | 72 |
| | 2. Sources And Uses Of Nuclear Applications | 73 |
| | 3. Key Applications | 75 |
| | 4. Market Strategy Implications | 77 |
| | D. Project Management | 78 |
| | 1. Introduction | 78 |
| | 2. Sources And Uses Of Project Management | 80 |
| | 3. Key Applications | 84 |
| | 4. Market Strategy Implications | 87 |
| | E. Graphics/Plotting | 89 |
| | 1. Introduction | 89 |
| | 2. Sources And Uses Of Graphics | 89 |
| | 3. Key Applications | 92 |
| | 4. Market Strategy Implications | 92 |
| V | COMPETITIVE ANALYSIS..... | 93 |
| | A. RCS Vendor Selection | 93 |
| | 1. Study Analysis | 93 |
| | 2. Results | 96 |
| | 3. Marketing Strategy Implications | 99 |
| | B. Profile Of Leading RCS Vendors | 100 |
| | 1. Characteristics Of First-Tier RCS Vendors | 100 |
| | 2. Control Data Corporation - Cybernet | 102 |
| | a. Overview | 102 |
| | b. Major Strengths | 104 |
| | c. Marketing Strategies | 104 |
| | 3. McDonnell Douglas Automation Company | 105 |
| | a. Overview | 105 |
| | b. Marketing Strategy | 106 |

Page

4. United Telecom Computer Group - United Information Services, Inc. 108
   a. Overview 108
   b. Major Strengths 108
   c. Marketing Strategy 109
5. Boeing Computer Services 110
   a. Overview 110
   b. Major Strengths 110
   c. Marketing Strategy 110
6. University Computing Company 111
   a. Overview 111
   b. Major Strengths 111
   c. Marketing Strategy 112

C. Leading Software Vendors 112
   1. Project Software And Development, Incorporated 113
   2. MacNeal-Schwendler Corporation 114

VI CONCLUSIONS AND RECOMMENDATIONS ..... 115
A. Major Marketplace Changes 115
   1. Processing Services 115
   2. Professional Services 115
   3. Integrated Systems 115
   4. Software Sales 116
B. Competitive Activity And Trends 116
   1. Processing Services 116
   2. Integrated Systems 117
   3. Software Sales 117
C. Recommendations 117

APPENDIX A: USER QUESTIONNAIRE ..... 121

APPENDIX B: VENDOR QUESTIONNAIRE ..... 145

# OPPORTUNITIES FOR ENGINEERING AND SCIENTIFIC REMOTE COMPUTING SERVICES

## EXHIBITS


| | | | Page |
|---|---|---|---|
| I | -1 | Respondent Profile By Industry | 6 |
| II | -1 | Opportunities For Engineering/Scientific Remote Computing Services | 9 |
| | -2 | Engineering/Scientific Marketplace Trends | 11 |
| | -3 | Per-customer RCS Spending Has Been Shrinking | 13 |
| | -4 | Most Engineering/Scientific Computing Is Done In-house | 15 |
| | -5 | The Total RCS Engineering/Scientific Market Will Grow Slowly | 17 |
| | -6 | Some Applications Will Grow Strongly | 19 |
| | -7 | Other RCS Applications Will Languish | 21 |
| | -8 | Some Customer Needs Remain The Same - Others Diminish | 23 |
| | -9 | INPUT Recommendations | 25 |
| | -10 | INPUT Recommendations | 27 |
| III | -1 | Changes In The Engineering/Scientific Marketplace, 1979-1988 | 34 |
| | -2 | Current Spending On Computing Modes | 36 |
| | -3 | Spending Changes For Computing Modes | 37 |
| | -4 | Projected Spending On Computing Modes, 1983-1986 | 39 |
| | -5 | Growth Rates for Computing Modes, 1983-1986 | 40 |
| | -6 | Reasons To Choose A Computing Mode | 42 |
| | -7 | Comparison Of Support Modes | 44 |
| | -8 | Engineering/Scientific RCS Markets, 1983-1988 | 46 |
| | -9 | RCS Engineering/Scientific Market Shares By Application, 1983 | 47 |
| | -10 | RCS Engineering/Scientific Market Shares By Application, 1988 | 48 |
| | -11 | Other Engineering/Scientific RCS Markets, 1983-1988 | 50 |
| | -12 | Engineering/Scientific Application Sources | 53 |
| | -13 | Engineering/Scientific Computing Modes By Discipline | 54 |
| | -14 | Changes In Spending And Work Load | 55 |
| IV | -1 | Structural Engineering Applications Sources | 59 |
| | -2 | Structural Engineering Applications Computing Modes | 61 |
| | -3 | Civil Engineering Applications Sources | 67 |
| | -4 | Civil Engineering Applications Computing Modes | 69 |
| | -5 | Nuclear Engineering Applications Sources | 74 |

| | | | Page |
|---|---|---|---|
| | -6 | Nuclear Engineering Applications Computing Modes | 76 |
| | -7 | Project Management Applications Sources | 81 |
| | -8 | Project Management Applications Computing Modes | 83 |
| | -9 | Graphics/Plotting Applications Sources | 90 |
| | -10 | Graphics/Plotting Applications Computing Modes | 91 |
| V | -1 | RCS Vendor Selection Criteria | 94 |
| | -2 | Reasons To Choose An RCS Vendor | 95 |
| | -3 | Customer Versus Vendor Ratings Of RCS Vendor Selection Criteria | 98 |
| | -4 | Major Engineering/Scientific RCS Vendor Sizes | 103 |

# 1 INTRODUCTION

# I INTRODUCTION

## A. PURPOSE AND SCOPE

- This report is produced by INPUT as part of the 1983 Information Services Industry Program. It examines and forecasts the engineering and scientific remote computing services market. The study was undertaken because clients were highly interested in the engineering/scientific marketplace, and new information was scarce.

- Particular emphasis was placed on researching the following disciplines:

  - Structural engineering.

  - Civil engineering.

  - Nuclear engineering.

- The following cross-industry applications were also examined in detail:

  - Project management.

  - Graphics/plotting.

- The areas of computer-aided design (CAD) and computer-aided manufacturing (CAM) were excluded from consideration in this study.

- The prime users of engineering/scientific information services were included:

  - FORTUNE 1000 engineering departments.

  - Architects and engineers.

  - Consulting engineers.

  - Governmental engineering departments.

  - Other industries that had major engineering requirements.

- Two groups were excluded from the study because of their budgetary constraints, which have caused an historical disuse of outside engineering/scientific information services:

  - Educational institutions.

  - Research foundations.

- This study examines the changing engineering/scientific computing environment and analyzes the causes of the changes. Particular emphasis is placed on the following key issues:

  - The changing engineering job. The study examines how the engineer's or scientist's day-to-day job has changed over the past five years.

  - The impact of computer technology on engineering computing. In particular, the study examines how other computing modes (personal computers, minicomputers, and information systems data centers)

affect the use of information services provided by outside remote computing services (RCS) vendors.

- The decision-making role of the engineer in selecting a computing mode.

- An analysis of these issues as well as current and emerging engineering/scientific computing needs was used to develop recommendations for vendors of processing services.

- In addition, the study focuses on several major vendors of engineering/scientific processing services and provides a profile of the services they offer, their industry and applications specialties, and their innovative marketing thrusts.

## B. DEFINITIONS

- To provide a conceptual framework for understanding how engineering/scientific computing is changing, it was necessary to categorize and define the various computers and computing methods. These differences are referred to as the "computing mode" throughout this report. The following definitions of computing mode will be used in this report to lend precision and clarity to these otherwise imprecise, generally used terms:

  - Personal Computer. A personal computer is a single-user computer with its associated peripherals. Prices on these units usually range from several hundred to several thousand dollars. Some newer personal computers are being designed specifically for engineers and are dubbed "engineering workstations."

- Minicomputer. A minicomputer, for purposes of this report, is a small multiuser computer that, when bundled with peripherals, costs less than $300,000. Some computers that have traditionally been labeled "minis," notably those from Prime Computer and the VAX series from Digital Equipment Corporation, are often configured so that their total value exceeds $300,000. Such installations were put in the following category.

- Information Systems Data Center. An information systems (IS) data center is a corporate-level computing resource that exceeds $300,000 in total valuation. In addition to satisfying the computing needs of the engineer, this facility typically handles a firm's day-to-day data processing needs. Indeed, this is frequently its dominant role. In such a case, the engineering/scientific computing support is often a secondary or even tertiary role for the computer.

- Remote Computing Service. A remote computing service (RCS) is a computer service that provides data processing through terminals at the user's site. The terminals are connected to the RCS vendor's computer through a data communications network. Subsets of this category include interactive or timesharing computing, remote batch processing, data base manipulation of a vendor-maintained data base, and user site hardware services (USHS).

## C. METHODOLOGY

- Research for this report was based on a series of personal and telephone interviews conducted by INPUT during April and May 1983.

- Prospective respondents were selected randomly from the industries noted previously. Care was taken to ensure that an even geographical and industrial distribution of respondents was achieved.

- Forty-four in-depth user interviews were conducted. An additional 20 "short-form" interviews were conducted to add statistical validity to the forecasts. The respondents' profile is shown in Exhibit I-1.

- A copy of the user questionnaire is included in Appendix A.

- Eight vendor interviews were also conducted for this study. Four of them were from the RCS community, and four were computer manufacturers or software firms.

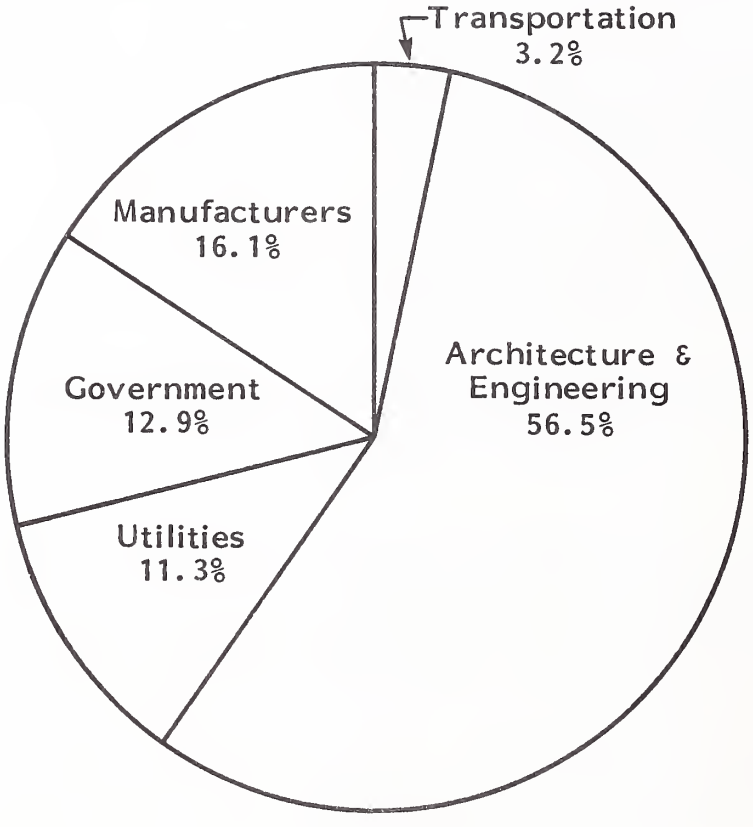
- A copy of the vendor questionnaire is included in Appendix B.

- INPUT clients and industry experts were also contacted for ideas and suggestions.

- Totals and growth rates were derived from respondents' answers. In most cases, the figures have been rounded to the nearest $5 million to eliminate the implication of a higher degree of accuracy than should be inferred from the data.

EXHIBIT I-1

RESPONDENT PROFILE BY INDUSTRY



# II EXECUTIVE SUMMARY

## II EXECUTIVE SUMMARY

- Note: this executive summary is designed in a presentation format in order to:

  - Help the busy reader quickly review key research findings.

  - Provide a ready-to-go executive presentation, complete with a script, to facilitate group communication.

- The key points of the entire report are summarized in Exhibits II-1 through II-10. On the left-hand page facing each exhibit is a script explaining its contents.

## A. OPPORTUNITIES FOR ENGINEERING/SCIENTIFIC REMOTE COMPUTING SERVICES

- This report is produced by INPUT as part of the 1983 Information Services Industry Program (ISIP).

- The study was undertaken because of clients' interest in the engineering/scientific marketplace.

- The computer-aided design (CAD) and computer-aided manufacturing sectors (CAM) were excluded from this study in order to focus on important but under-researched areas.

- INPUT's research report:

  - Studies the prime users of engineering/scientific information services including engineering departments within the Fortune 1000, architectural and engineering firms, and governmental engineering departments.

  - Analyzes how other computing modes (such as personal or mini-computers) affect the use of services provided by remote computing services (RCS) vendors.

  - Studies the competitive situation in the engineering/scientific marketplace.

  - Recommends appropriate strategies that can be used by RCS vendors to hold onto old business and increase new business.

- The remainder of this presentation will provide highlights from INPUT's report.

EXHIBIT II-1

# OPPORTUNITIES FOR ENGINEERING/ SCIENTIFIC REMOTE COMPUTING SERVICES

- High Client Interest
- Fast Changes
- Excludes CAD/CAM
- Scope
  - Studied Prime Users of Engineering/Scientific Information Services
  - Shifts in Computing Modes
  - Competitive Response
  - Recommendations

## B. ENGINEERING/SCIENTIFIC MARKETPLACE TRENDS

- Computer technology changes will continue to have a profound effect on the marketplace.
  - The engineering workstation will emerge as a mainstay of the engineer's tool kit.
  - Major brand name engineering software packages will be widely available on a variety of minicomputers and engineering workstations.
  - Many engineering organizations will acquire their own in-house computer facility, which will further curtail outside services.
  - The engineer's job will become more computerized.
  - Vendors will take advantage of these technology trends by offering integrated systems.
- The administration and regulation of engineering/scientific work will change in the next five years. Software that has been validated or certified by independent tests against known engineering problems will increasingly be mandated by various governmental agencies. Engineering data bases for cost and design data will be marketed by forward-looking RCS vendors.
- The business climate seems more promising than it has in the past five years. Expected results include:
  - A pent-up demand for buildings, plants, and engineering works of all kinds after the past sustained period of slow or no growth. This demand will be fueled by the strong economic recovery and the need to add capacity.
  - No new nuclear power plants will be planned, however, and existing projects will be completed or delayed.

# ENGINEERING/SCIENTIFIC MARKETPLACE TRENDS

- Technology
  - Emergence of Engineering Workstations
  - Brand Name Software on Minis, Workstations
  - Shift to In-house Computers
  - Integrated Systems to Proliferate
- Administrative and Regulatory
  - "Validated" Software
  - Engineering Data Bases
- Business Conditions
  - Strong Recovery
  - Pent-up Demand for Engineering Projects
  - No New Nuclear Projects

## C. PER-CUSTOMER RCS SPENDING HAS BEEN SHRINKING

- The exhibit shows the past year's actual changes in spending for each computing mode.

- Although spending on personal computers has increased a dramatic 53%, it represents only 1% of the total engineering/scientific budget, which is due to the newness of this mode.

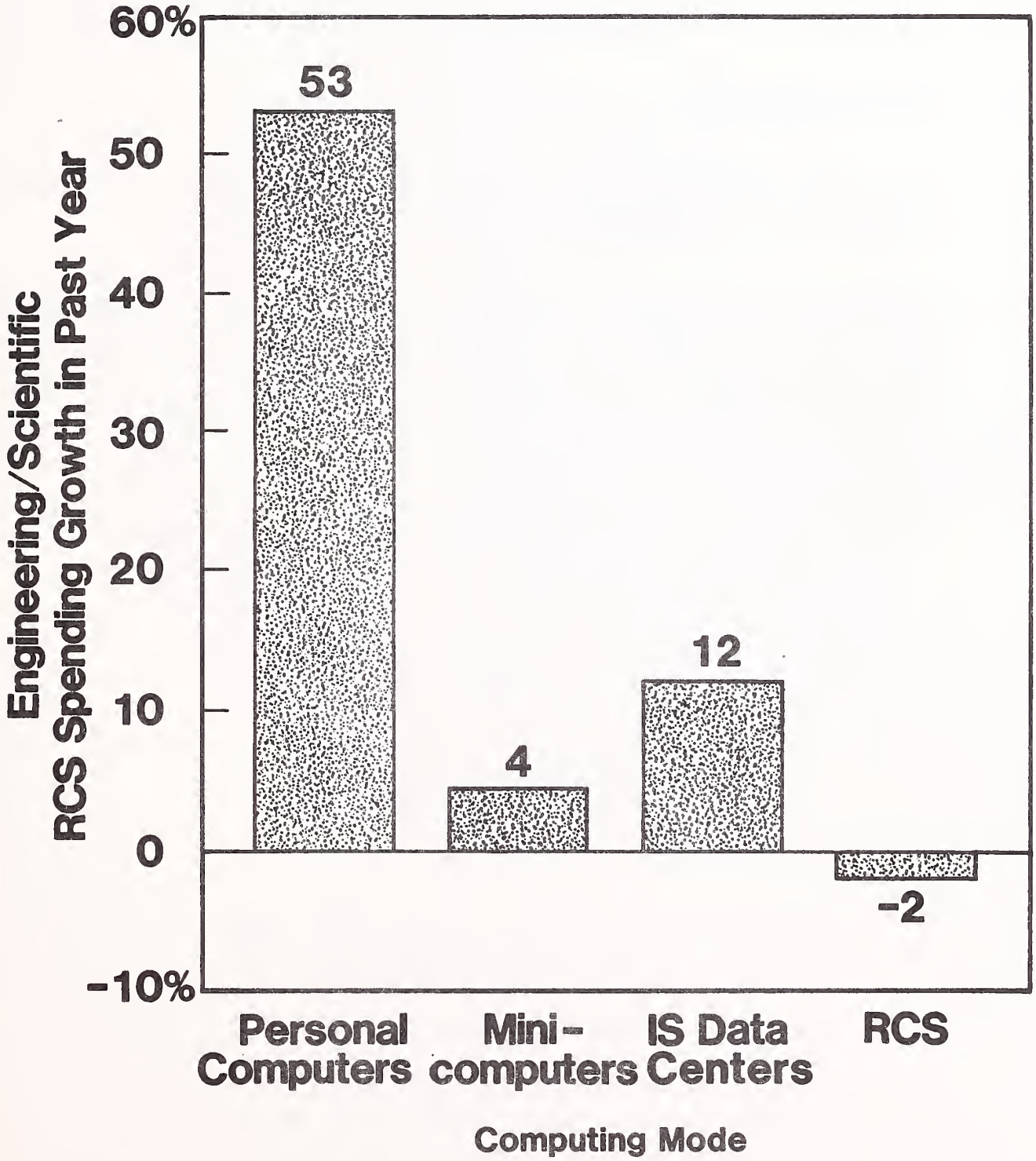
- Spending on minicomputers has increased slowly, by only 4%. It now accounts for 9% of the engineering/scientific budget.

- Typical respondents in the study spent 45% of their budgets with their IS departments' data centers. This computing mode has increased a solid 12% in the past year. Note, however, that in recessionary times such "soft-dollar" transactions are often decreed by the firm's financial conditions.

- Reflecting tight, cash-conscious economic conditions, typical respondents spent 2% less on RCS services than they did a year ago.

EXHIBIT II-3

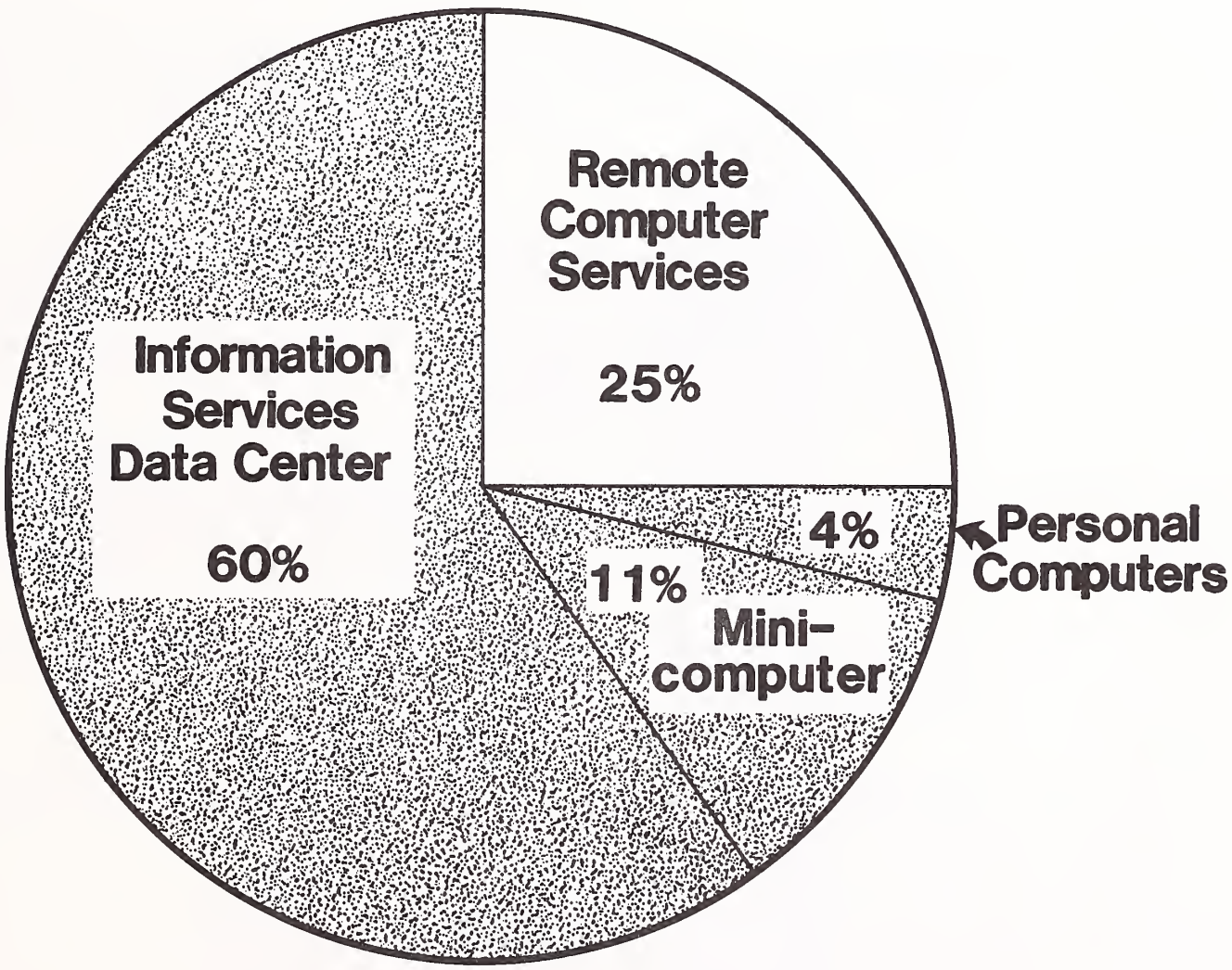
# PER-CUSTOMER RCS SPENDING HAS BEEN SHRINKING



## D. MOST ENGINEERING/SCIENTIFIC COMPUTING IS DONE IN-HOUSE

- This exhibit excludes spending on software to show how money is being spent for various computing modes by INPUT survey respondents.
- Personal computers have a very small share (4%) of in-house computing.
- Minicomputers also have a small share (11%).
- Most funds are spent with the in-house information systems data center. Sixty percent of the budget is spent in this mode.
- Considering recent economic conditions and the fact that RCS represents a "hard cash" expenditure, it is not surprising that RCS spending represents only 25% of the computing mode spending.

# MOST ENGINEERING/SCIENTIFIC COMPUTING IS DONE IN-HOUSE



## E. THE TOTAL RCS ENGINEERING/SCIENTIFIC MARKET WILL GROW SLOWLY

- INPUT's study revealed that the total market for engineering/scientific computing in the RCS mode will reach $705 million in 1983.

- The five-year forecast shows a 13% average annual growth rate for the total engineering/scientific RCS marketplace. The 1988 marketplace will reach $1.3 billion.

- After shrinking in the past recession-ridden year, spending on RCS is expected to rebound. Engineering firms will take advantage of the RCS mode's greatest strengths, quick delivery and low cost, to serve their computing needs in the near term.

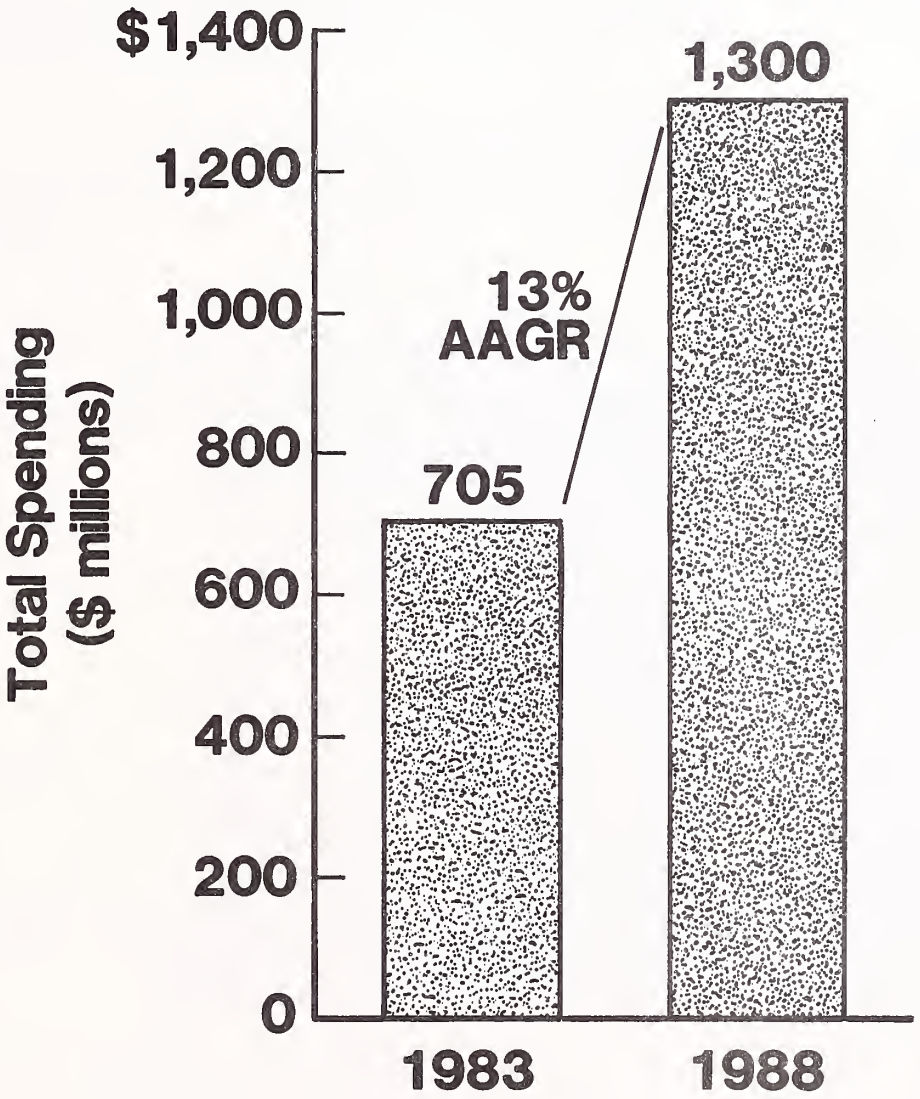
- Personal computers had been under evaluation at many sites. As in other fields, engineering/scientific personal computer growth will be explosive.

- The impressive growth of personal computers will steal some business away from minicomputers.

- Spending growth for information systems data centers will remain steady.

EXHIBIT II-5

# THE TOTAL RCS ENGINEERING/ SCIENTIFIC MARKET WILL GROW SLOWLY



## F. SOME APPLICATIONS WILL GROW STRONGLY

- The exhibit shows the RCS marketplace growth projections for several leading engineering disciplines. Growth in these disciplines is due to a continuing need for large-scale computing power.

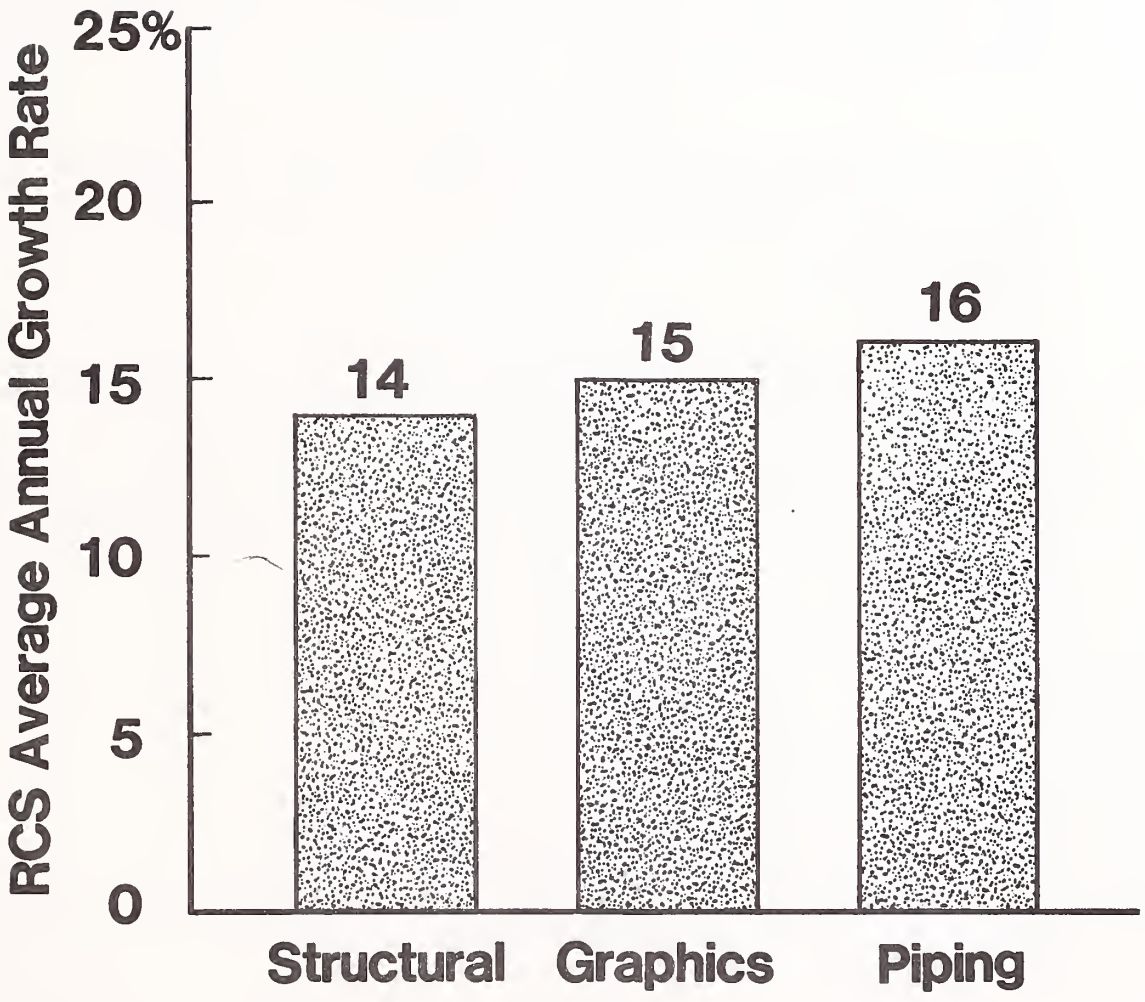
- Structural engineering will show a 14% average annual growth rate over the next five years. Total market size will reach $420 million in 1988.

- Graphics and plotting are becoming increasingly important. Average annual growth rate is projected to be 15%. The 1988 RCS marketplace is expected to be $59 million.

- Piping is the fastest growing RCS engineering/scientific computing application at an annual growth rate of 16%. The 1988 RCS marketplace for piping applications is projected to be $105 million.

EXHIBIT II-6

# SOME APPLICATIONS WILL GROW STRONGLY



## G. OTHER RCS APPLICATIONS WILL LANGUISH

- Some engineering/scientific RCS applications will show little growth over the next five-year period.

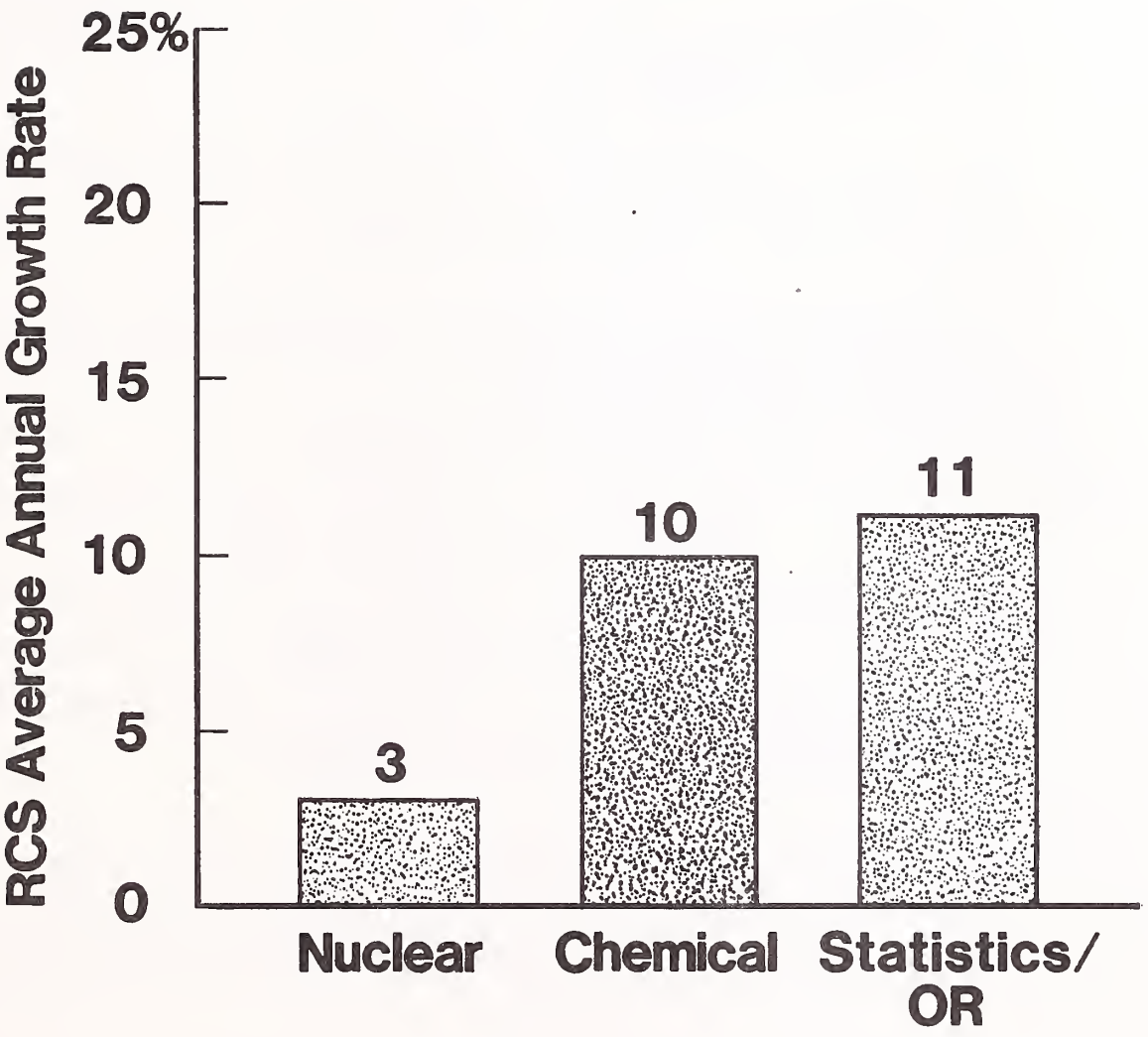
- The overall decline of the nuclear power industry will contribute to the lack of significant growth for nuclear engineering RCS business. With an average annual growth of just 3%, nuclear engineering is expected to generate $34 million in RCS revenues in 1988.

- Due to the current oil glut, chemical and process engineering applications will grow by a lacklustre 10%. The total market size is expected to reach $31 million by 1988.

- Statistics and operations research (OR) applications, on the other hand, will shift strongly to other computing modes - principally mini and personal computers. The shift will result in a slow 11% growth for statistics and OR applications within the RCS industry. The 1988 market size is expected to be $30 million.

EXHIBIT II-7

# OTHER RCS APPLICATIONS WILL LANGUISH



## H. SOME CUSTOMER NEEDS REMAIN THE SAME - OTHERS DIMINISH

- INPUT asked respondents why they select certain vendors.

- Customers still want many of the traditional benefits of a successful customer-vendor relationship.

  - The quality of an RCS vendor's support is the primary reason for choosing a particular vendor.

  - The relative price/performance of the RCS vendor was rated the second most important selection criterion.

  - The availability of software, especially when the vendor had an exclusive package to offer, was third.

- Features that were formerly important selling points are less important now.

  - Supercomputers are no longer a requisite for a successful RCS vendor. The emergence of acceptably high-speed IBM and compatible CPUs, when combined with increasing concentration on packaged software, has caused this former "hot button" to turn cold.

  - RCS customers feel no particular loyalty to their vendors. New projects requiring RCS support will be given to the appropriate RCS vendor based on the needs of the project, not on a preexisting contract.

# SOME CUSTOMER NEEDS REMAIN THE SAME - OTHERS DIMINISH

- Customers Still Want:
  - Support
  - Good Price/Performance
  - Engineering/Scientific Software
- But No Longer Value:
  - Supercomputers
  - RCS Business Relationships

## I. INPUT RECOMMENDATIONS

- RCS vendors must develop strategies that simultaneously offer good price performance and excellent support. This can be accomplished by:

  - Centralizing applications expertise. Good telephone application support is more important than local support.

  - Offering regional training. Periodic, in-depth, regional training will develop in-house experts but will lower training costs.

  - Deemphasize local support. A few known experts based at the home office provide better support than inexperienced local personnel.

- Hardware is now inexpensive enough to be placed in distributed locations. Provide hardware and software support from the central facility.

  - Smaller mainframes such as the IBM 4341 can be placed in branch offices to provide superior interactive access.

  - Minicomputers such as the VAX 11/730 can be rented to customers.

EXHIBIT II-9

# INPUT RECOMMENDATIONS

- Maximize Support and Minimize Costs
  - Centralize Applications Expertise
  - Offer Regional Training
  - Deemphasize Local Support
- Distribute Hardware
  - Branch Office Mainframes
  - User Site Hardware

## J. INPUT RECOMMENDATIONS (continued)

- RCS vendors need to support computing mode integration for their engineering/scientific customers.

  - Small computers on the user's site can be utilized as pre- and post-processors for RCS applications.

  - Proprietary telecommunications or other software will make it easier to use a given RCS vendor.

  - Major RCS vendors are already offering integrated systems to new and existing customers.

  - Proprietary software given or rented to a customer will be very effective in attracting or retaining engineering customers.

- RCS vendors need to diversify their offerings by increasing the number of delivery modes. Software sales and integrated systems will offer significant opportunities in the next five years.

- INPUT recommends that RCS vendors use in-house marketing experience to acquire rights to high-need software products. These can then be offered on the RCS mainframe, delivered via an integrated system, or sold as a stand-alone package.

EXHIBIT II-10

# INPUT RECOMMENDATIONS

- Broaden Computing Mode Support
  - Integrate Small Computers
  - Maximize Proprietary Software
  - Offer Integrated Systems
  - Support User Site Software
- Offer Alternative Delivery Modes
- Capitalize on Marketing and Sales Strengths

# III MARKET ANALYSIS AND FORECASTS

# III MARKET ANALYSIS AND FORECASTS

## A. CHANGES IN THE MARKETPLACE, 1979-1988

### 1. TECHNOLOGICAL CHANGES, 1979-1983

- The past five years have not seen major changes in the fundamental scientific content of the engineering/scientific profession; the engineer's analysis and design algorithms have remained static. The major technology changes in this marketplace have been due to the rapidly improving technology of computer hardware and software.

- The slide rule has completely disappeared. In its place is an array of calculators, programmable calculators, and personal computers.

- Use of RCS computers to solve low- and medium-level problems has greatly decreased. Programmable computers are now offered with a variety of "applications packs" to provide answers to many simple engineering problems.

- More of the engineering work is now being done on a computer, and less hand work is required.

- Engineering work is often more detailed today. An analysis of two or even three alternative solutions is now frequently performed on a computer.

- The design and analysis cycle has sped up. Competitive and economic pressures have shortened the time allowed for a task or project to be designed. This has led to increased use of computers which has, in turn, created a shorter design cycle.

- The manual process of drafting, whether performed by an engineer or a draftsman, is in the process of being automated by computer-aided design (CAD) equipment.

- The engineering community is increasingly bringing their computing work in-house. The increased speed and decreased cost of all types of computers have encouraged the acquisition and use of in-house computers. This factor has dramatically cut into the use of outside processing services by engineers.

2. TECHNOLOGICAL CHANGES, 1983-1988

- The changes in the technology of computers and software will continue to have an effect on the engineering/scientific marketplace.

- The engineering workstation will emerge as one of the mainstays of the engineer's tool kit. Packing the processing power and storage capacity of a mainframe of a few years ago, these specially designed personal computers and microcomputers will offer both hardware and software to solve many day-to-day engineering problems.

- Major brand name engineering software packages that are now available only on RCS or other mainframe computers will become available for use on a wide variety of engineering workstations. Subsets of the popular NASTRAN and ANSYS structural engineering packages are already available for the Apollo computer.

- The trend toward lower computing cost and faster speed will continue. Many firms and departments will be able to acquire their own computational facilities and will discontinue or curtail the use of outside computing services.

- The total range of engineering tasks will be increasingly computerized. Tasks such as preliminary design, drafting, analysis, final approval, and manufacturing setup will be performed on a computer, with the various software packages passing data from one to the other.

- The major information services vendors will recognize these trends and will offer integrated systems. These systems will use engineering workstations to perform the front-end processing and engineering setup; they will then pass the problem off to an RCS mainframe for "crunching." INPUT expects that the most successful RCS vendors will offer a line of proprietary user site hardware services (USHS) and user site software.

3. ADMINISTRATIVE AND REGULATORY CHANGES, 1979-1983

- The engineering profession is undergoing changes in the way the job is administered and regulated.

- The Nuclear Regulatory Commission (NRC) required that programs or codes used in nuclear energy work be "certified." This is a quality assurance process for software that applies to all programs used in the engineering of nuclear power plants. This certification is something that in-house engineering departments cannot usually afford, and that software package vendors have yet to implement. Several RCS vendors have recognized the opportunity in this problem and have shouldered the responsibility of maintaining their software in a "certified" status.

- Increased need for cost control and new regulations has increased the amount of documentation and reporting required on engineering projects. Indeed, several INPUT respondents reported that the major use of their personal computer or minicomputer was word processing.

4. ADMINISTRATIVE AND REGULATORY CHANGES, 1983-1988

- The impact of computing and regulatory changes will continue to be felt in the administration of engineering/scientific work.

- The idea of verified or validated engineering software will continue to spread. INPUT expects that, by the end of the period, several regulatory bodies as well as professional societies will have standards for subjecting engineering software to independent, verifiable tests. Both RCS and software vendors can increase the marketability of their offerings by establishing programs or procedures to validate their software.

- Engineering data bases for cost and design data will be built and marketed by pioneering RCS vendors.

5. BUSINESS CONDITION CHANGES, 1979-1983

- The general business climate has had a substantial impact upon the engineering/scientific marketplace in the past five years. The world economy has undergone the most severe economic downturn since the 1930s. This has caused cutbacks and cancellations of engineering projects in all phases of the industry.

- The nuclear power industry has virtually ceased new development. Not only have there been no new orders for nuclear plants in the period, but a number of the existing projects have been cancelled. Many of the successful nuclear engineering firms have shifted their emphasis from new project work to reanalysis and redesign of existing plants.

- The oil and energy shortage that marked the beginning of the period has been replaced with a "glut." Engineering projects in exploration, production, and refining have been drastically cut back or cancelled.

6. BUSINESS CONDITION CHANGES, 1983-1988

- As in the past five years, the general business outlook and economic conditions will strongly affect the engineering/scientific marketplace.

- Most of the engineering and computing spending growth reported by the respondents to this survey was a result of the newly improved business climate. After a sustained period of slow or no growth, there is a pent-up demand for buildings, plants, and engineering works of all types.

- The prospect for nuclear engineering, however, is not bright. The bulk of existing projects now under development will be completed during the period, and there is no new work to be undertaken. The mainstay of nuclear A&E firms will remain reanalysis and redesign.

- A summary of these changes and their impact on the business of RCS vendors is shown in Exhibit III-1.

## B. ANALYSIS OF COMPUTING MODES

- The typical engineering/scientific firm or department now has a variety of computing modes - ways to get the answers they need for their engineering problems. As part of the survey conducted for this report, INPUT performed a detailed analysis of the respondents' computing modes for engineering/scientific computing work. This portion of the study examined:

  - Current spending: How are respondents spending their engineering/scientific computing dollar? Are they buying personal computers or minis? Are they allocating their money to IS data centers or RCS vendors?

EXHIBIT III-1

CHANGES IN THE ENGINEERING/SCIENTIFIC MARKETPLACE, 1979-1988

| CHANGES IN THE MARKETPLACE, 1979-1988 | IMPACT ON RCS BUSINESS |
|---|---|
| **Technology Changes, 1979-1983** | |
| Widespread use of calculator, programmable calculator. | - |
| More engineering work computerized. | ++ |
| More detailed, thorough engineering analysis. | + |
| Speeded up design and analysis cycle. | + |
| Manual drafting partially replaced by CAD. | - |
| Increased use of in-house computers. | --- |
| **Technology Changes, 1983-1988** | |
| Emergence of engineering workstation. | -- |
| Major software packages available on many nonmainframes. | -- |
| Continued trend to lower cost, higher speed computers. | - |
| Integrated, computerized engineering cycle. | + |
| RCS vendors offer packaged user site hardware and software. | +++ |
| **Administrative & Regulatory Changes, 1979-1988** | |
| Emergence of "audited" engineering application. | + |
| Increased documentation and reporting requirements. | + |
| **Administrative & Regulatory Changes, 1983-1988** | |
| Wider use of "audited" engineering application. | ++ |
| Engineering cost and design data bases in use. | + |
| **Business Condition Changes, 1979-1983** | |
| Severe recession. | --- |
| New nuclear power plant orders vanish, projects cancelled. | - |
| Oil & gas "glut" emerges. | -- |
| **Business Condition Changes, 1983-1988** | |
| Recession ends, economic recovery completed. | +++ |
| Existing nuclear projects completed, no new ones started. | - |

Key: Extent of Impact

+++ = Very positive
++ = Positive
+ = Somewhat positive
- = Somewhat negative
-- = Negative
--- = Very negative

- Change in spending patterns: How have respondents changed their spending patterns in the past 18 months?

- Projected spending patterns: How will respondents, based on current plans, spend money in the next 18 months?

- Computing mode selection criteria: What measures do engineering/scientific firms and departments use in selecting a computing mode? What is most important? What is unimportant?

## I. CURRENT SPENDING

- Current software spending: Spending for engineering software is now commonplace. The spending in this category consists of one or more of the following:

  - Software development costs: Much engineering/scientific software is internally developed. Costs include development, personnel, computing, and overhead.

  - Software rental or purchase: Most frequently software is "purchased" from outside suppliers. Increasingly, however, engineering/scientific software is being rented. Spending on software accounted for 16.6% of the total among our respondents as shown in Exhibit III-2. Business conditions have depressed the recent change in spending, however. Spending on software has grown only 1.1% in the past 12 months, as shown in Exhibit III-3.

- Current personal computer spending: Personal computers are new to most engineering firms or departments. Many of the respondents had just recently purchased one or two on a trial basis. While the spending growth in this mode was a dramatic 53.2% over the past year, this brought the total spending up to only 1.0% of the total engineering/scientific computing budget.

EXHIBIT III-2

CURRENT SPENDING ON COMPUTING MODES

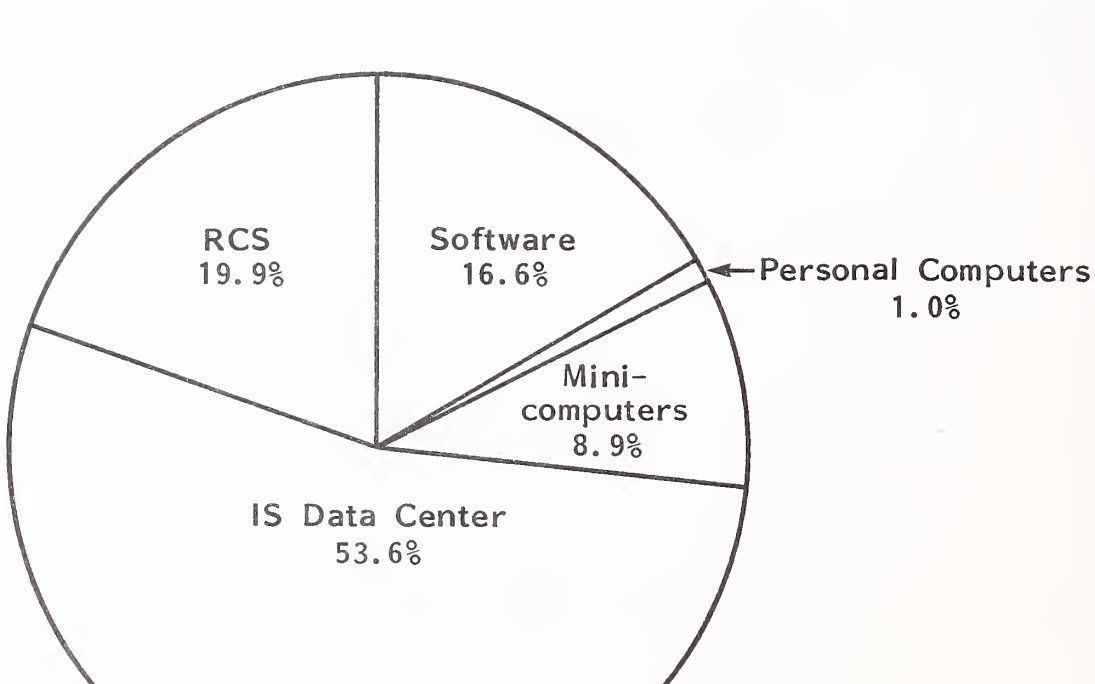
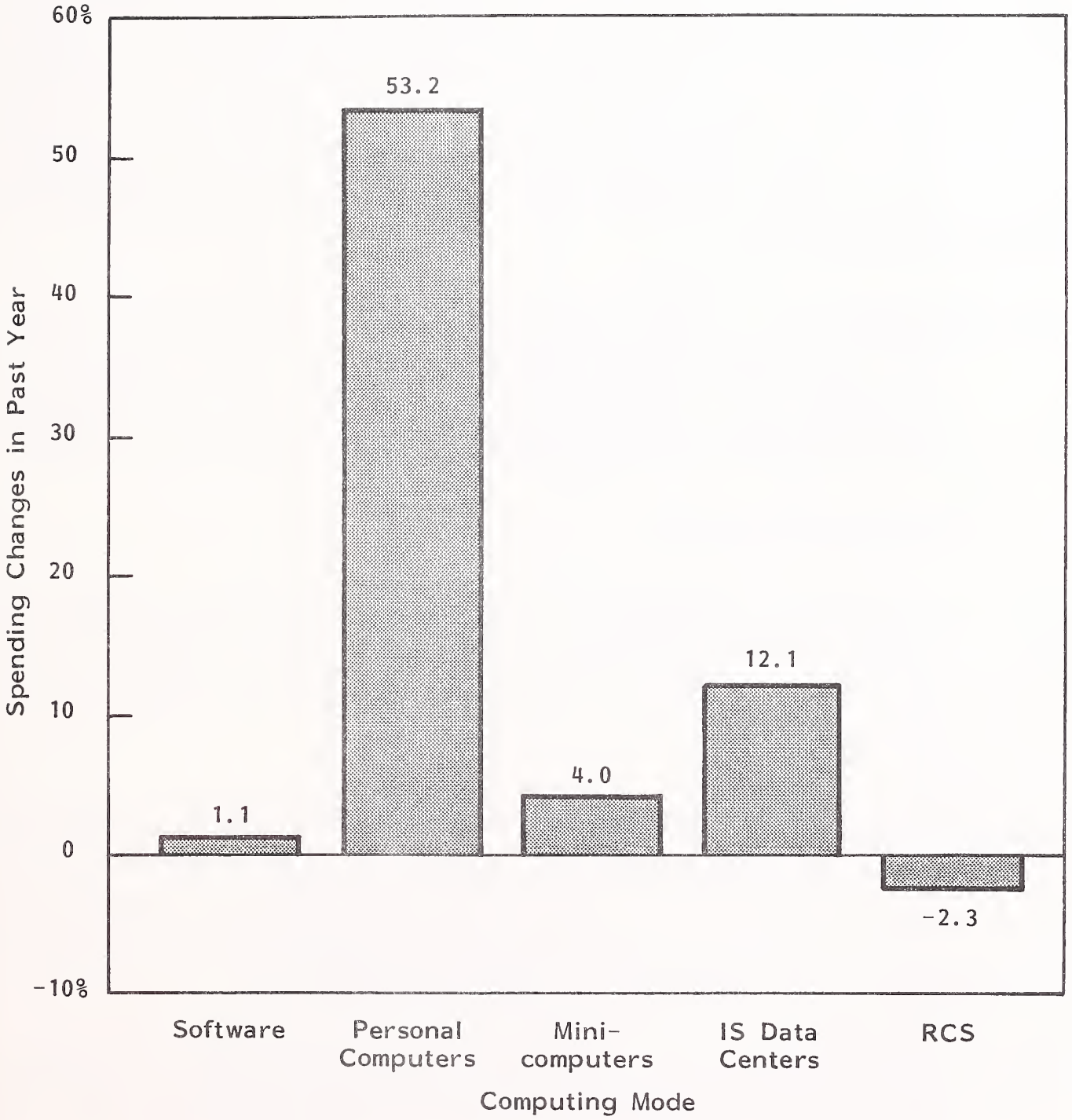


EXHIBIT III-3

SPENDING CHANGES FOR COMPUTING MODES



- Current minicomputer spending: Spending on minicomputers increased only 4.0% in the past year and accounted for 8.9% of the engineering/scientific budget.

- Current information systems data center spending: The typical respondent in this survey spent most of his engineering/scientific budget with the IS department, 53.6% of the total money. In recessionary times this can be the easiest and quickest way to increase computing capacity because spending on this mode is often a "soft dollar" transaction - only budgetary funds are transferred, not cash. Spending on the IS data center rose a respectable 12.1% in the past year.

- Current remote computing services spending: Although spending for outside computing services amounted to almost one-fifth of the engineering/scientific computing budget, 19.9%, this figure represented a recent decrease in expenditures. The typical respondent in our survey spent 2.3% less than a year ago.

2. PROJECTED SPENDING

- Projected software spending: Respondents' planned spending for software will stay the same, amounting to 16.6% of the budget, as shown in Exhibit III-4. This corresponds to a 16.7% growth rate over the next three years, as shown in Exhibit III-5.

- Projected personal computer spending: Many firms trying personal computers in the past year have rated them a success, so much so that spending for engineering/scientific personal computers was projected by respondents to grow at 238.9%. The starting point was small, however, so that the proportion of the total spending budget amounted to only 2.8%.

- Projected minicomputer spending: Spending on minicomputers is expected by respondents to drop 21.7% and to retain only 6.0% of the total budget. This

EXHIBIT III-4

PROJECTED SPENDING ON COMPUTING MODES, 1983-1986

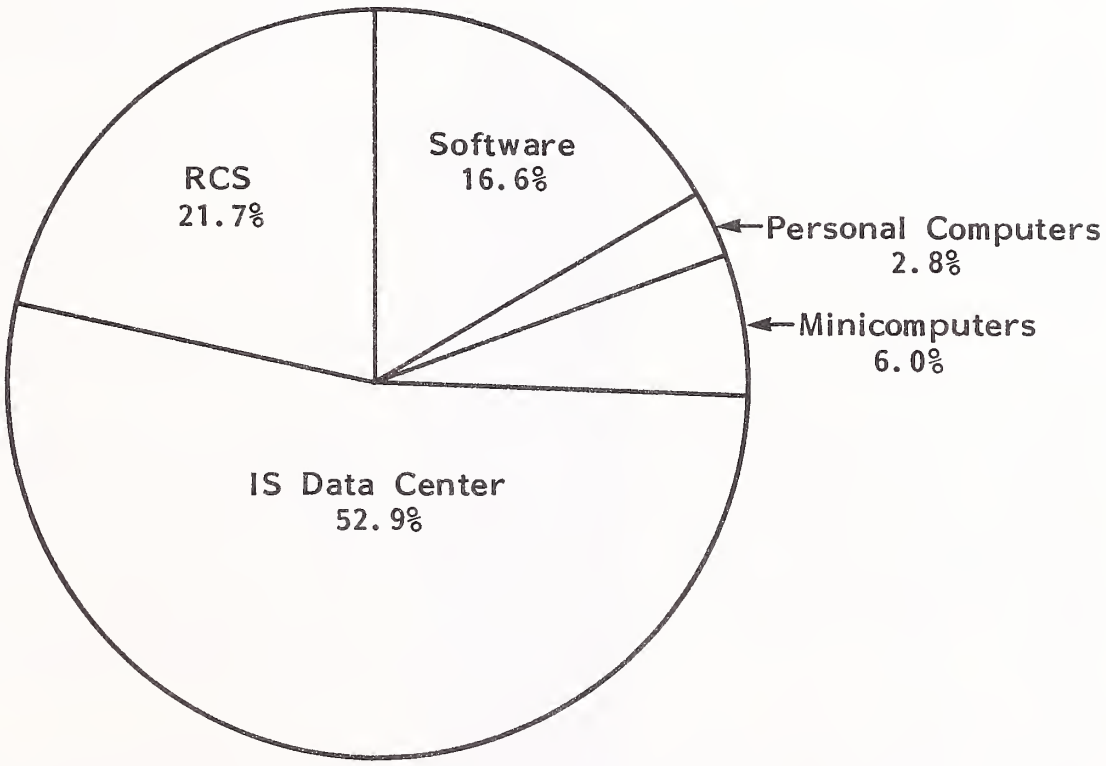
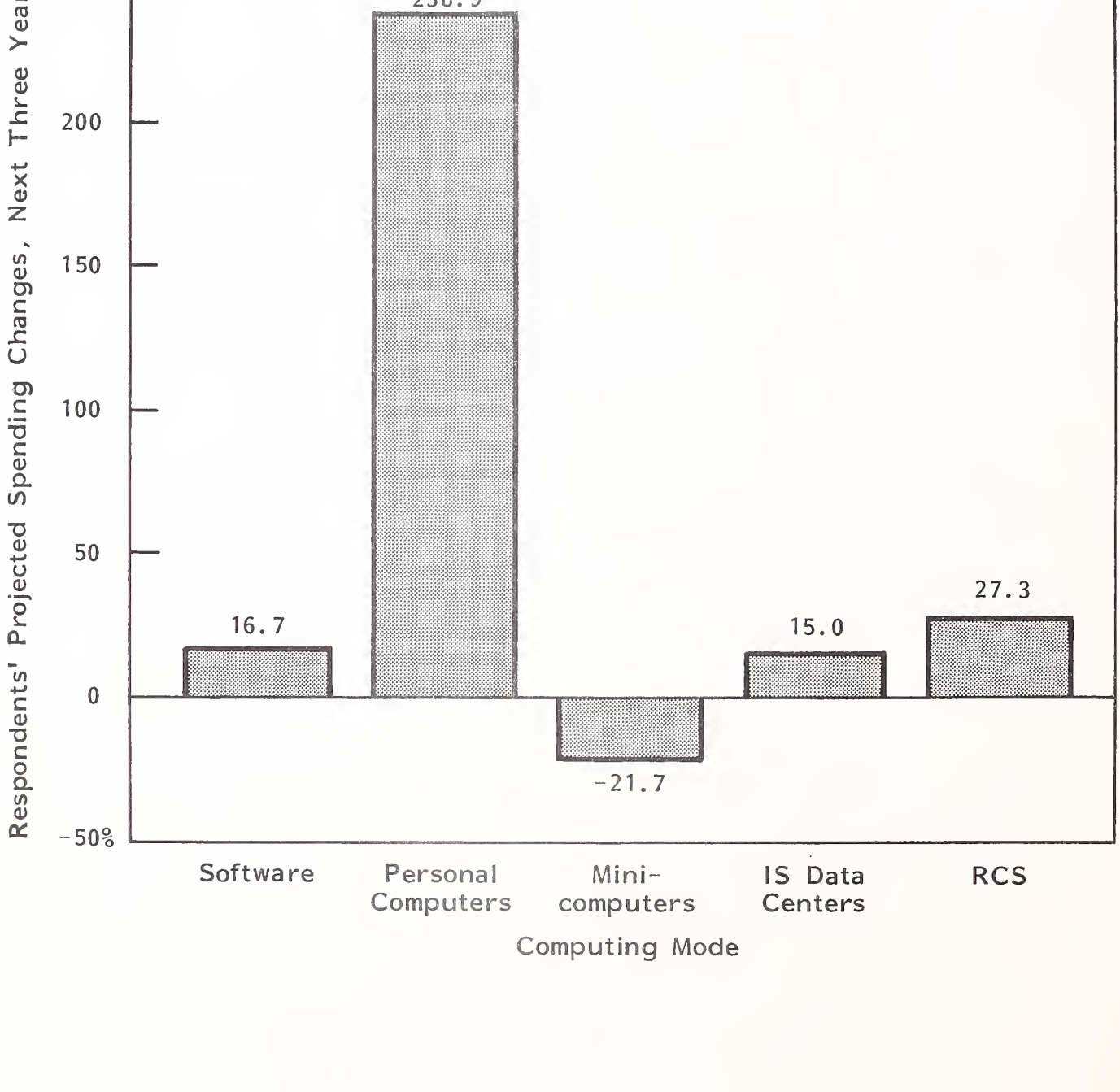


EXHIBIT III-5

GROWTH RATES FOR COMPUTING MODES,
1983-1986



reflects a trend away from middle ground within the engineering/scientific marketplace. For lightweight calculations, a personal computer will do. Any other type of computation requires the more robust processors found in IS data centers or with RCS vendors.

- Projected IS data center spending: IS data centers are expected to retain their majority share, 52.9% of spending. Growth of this computing mode will be a strong 15%.

- Projected RCS spending: Spending with RCS vendors is expected to rebound strongly up to a 21.7% share of the budget; respondents expect the annual growth to be 27.3%.

## 3. REASONS TO CHOOSE A COMPUTING MODE

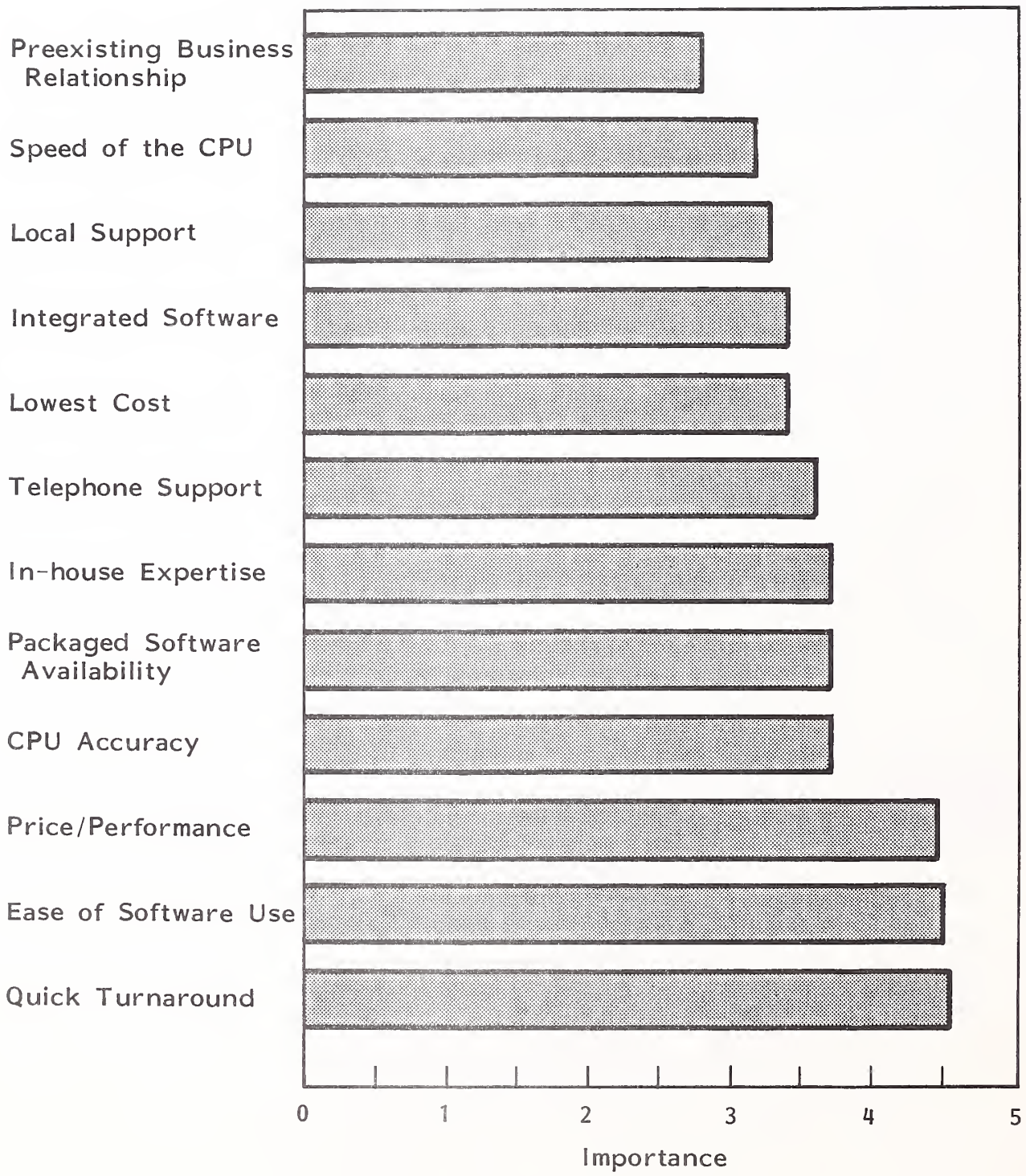
- INPUT identified 12 reasons that engineering/scientific decision makers use in selecting one of the computing modes. Respondents were asked to rate these reasons on a scale of 1 to 5, where a rating of 1 means that the reason is irrelevant, and a 5 means it is crucial or decisive. Exhibit III-6 depicts the average rating and the standard deviation.

- The most important reason, and the one on which there was the most agreement, is turnaround, the speed with which a given computing task will begin, complete its processing, and be available for analysis by the engineer after it completes. To many firms the cost of their engineers is far more important than the savings of using an efficiently loaded computer. Modern competitive pressures have exacerbated this problem by shortening project durations.

- RCS vendors have historically offered a higher priority service at an increased cost. The surcharge over regular turnaround can be as high as 400%. Yet this service is in great demand by engineering/scientific customers.

EXHIBIT III-6

## REASONS TO CHOOSE A COMPUTING MODE



- At the other end of the scale, the speed of the CPU and the existence of a preexisting business relationship were judged least important.

## 4. THREE SUPPORT MODES

- The importance of three types of support was questioned in the survey. Exhibit III-7 illustrates how respondents felt about the various modes.

  - In-house expertise: In-house experts have extensive experience with the application and often take the lead in providing technical support to other users. From a vendor's point of view, these trained individuals are especially valuable because they contibute to the selection of the application, and they require relatively little support themselves.

  - Local support: Surprisingly, this support mode was least effective in swaying the respondents.

  - Telephone support: The availability of telephone support for an application proved almost as effective as in-house experts in choosing among computing modes.

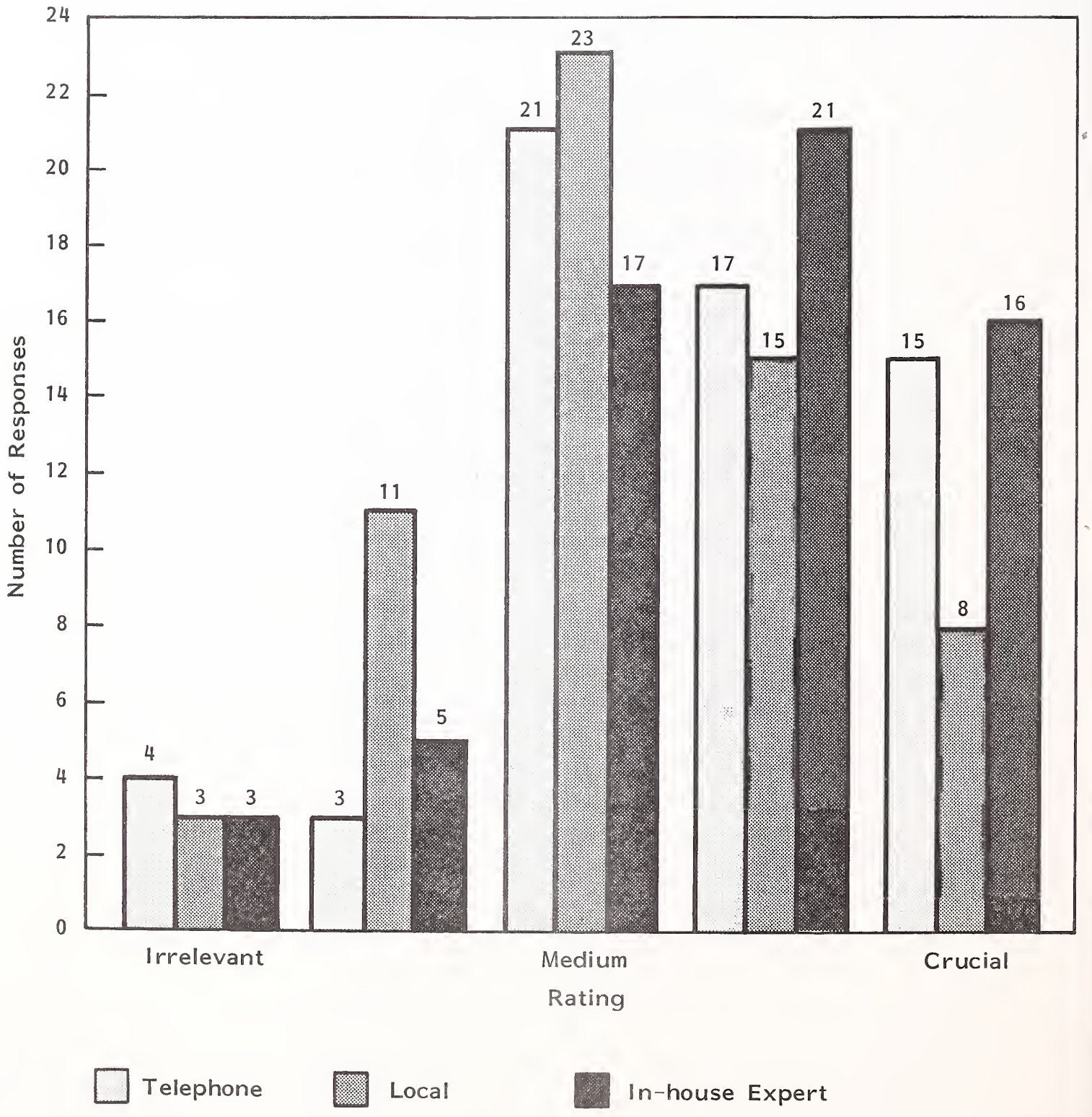
- An analysis of these responses suggests that software and RCS vendors would do well to adopt the following support strategies:

  - Develop a cadre of in-house experts. Offer in-depth training classes. Stimulate enthusiasm for the application by having the trained experts belong to a "club." Offer a newsletter or other regular technical notes.

  - Offer easy-to-use telephone support. Have a toll-free hotline that is manned over an extended work day (and perhaps even weekends). Be vigorous with follow-up.

EXHIBIT III-7

COMPARISON OF SUPPORT MODES



- Deemphasize the importance of a local support representatives. Have the existing support reps concentrate on providing training and shift the day-to-day support tasks to the telephone support center. Use any financial savings to increase the effectiveness of the steps above.

## C. MARKET FORECASTS, 1983-1988

- The total market for engineering/scientific computing in the RCS computing mode will grow from $705 million in 1983 to $1.3 billion in 1988. This represents a 13% AAGR, as shown in Exhibit III-8.

### 1. STRUCTURAL ENGINEERING

- The structural engineering marketplace is expected to have an AAGR of 13.8%. Its $220 million 1983 market represents 31.4% of the total market, the largest share, as shown in Exhibit III-9. It is expected to increase that share slightly in 1988, becoming a $420 million market, and owning 31.7% of the marketplace, as shown in Exhibit III-10. This application was extensively analyzed by INPUT and is discussed further in Chapter IV.

### 2. PROJECT MANAGEMENT

- Project management will grow from $165 million in 1983 to $305 million by 1988. This represents an AAGR of 13%. This market holds a 23.3% share in 1983 and is expected to retain it in 1988. This application will also be discussed further in Chapter IV.

### 3. ELECTRICAL/ELECTRONIC ENGINEERING

- Electrical engineering applications are expected to grow from $120 million in 1983 to $230 million by 1988, an AAGR of 13.9%. Included in this category are

EXHIBIT III-8

ENGINEERING/SCIENTIFIC RCS MARKETS, 1983-1988

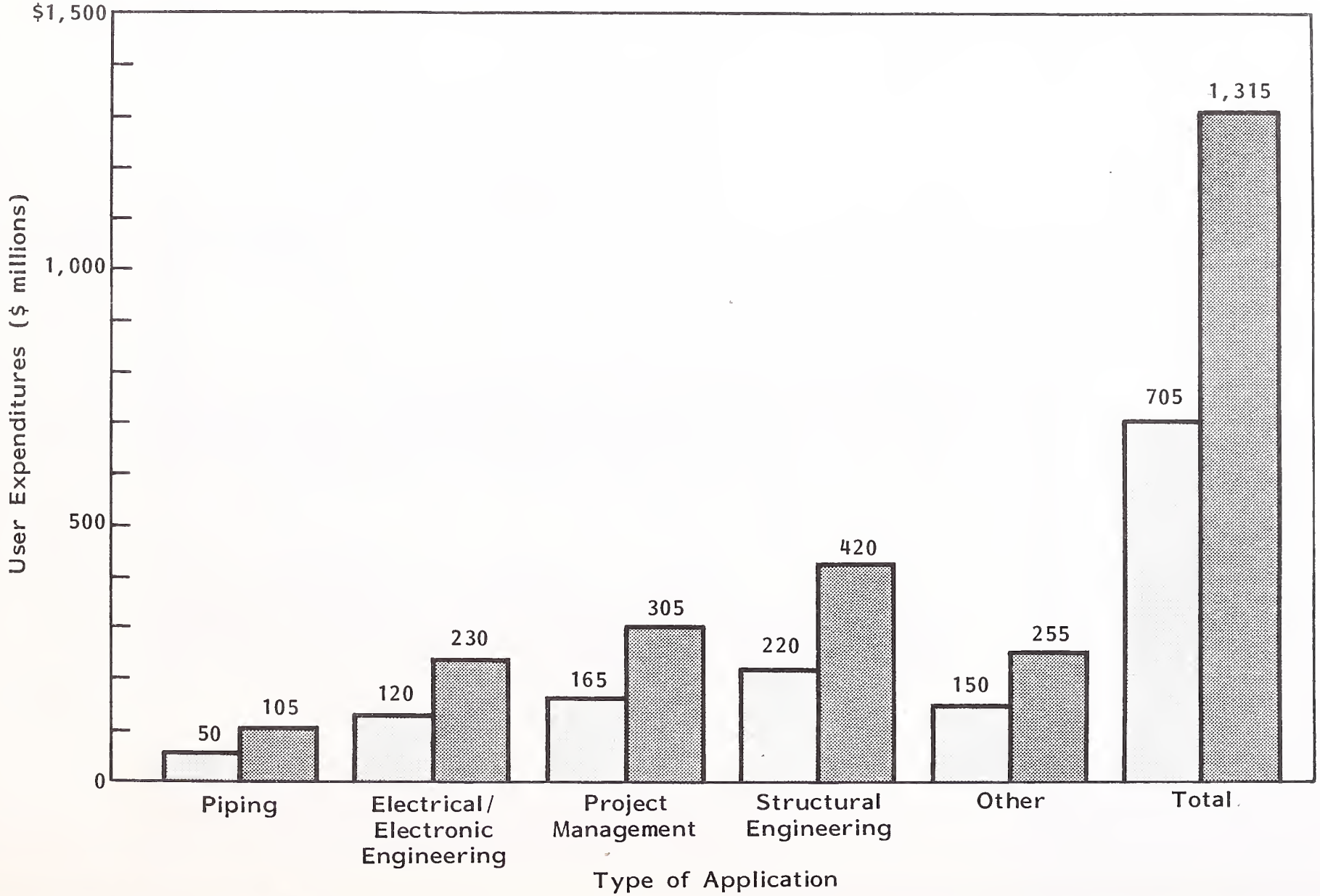
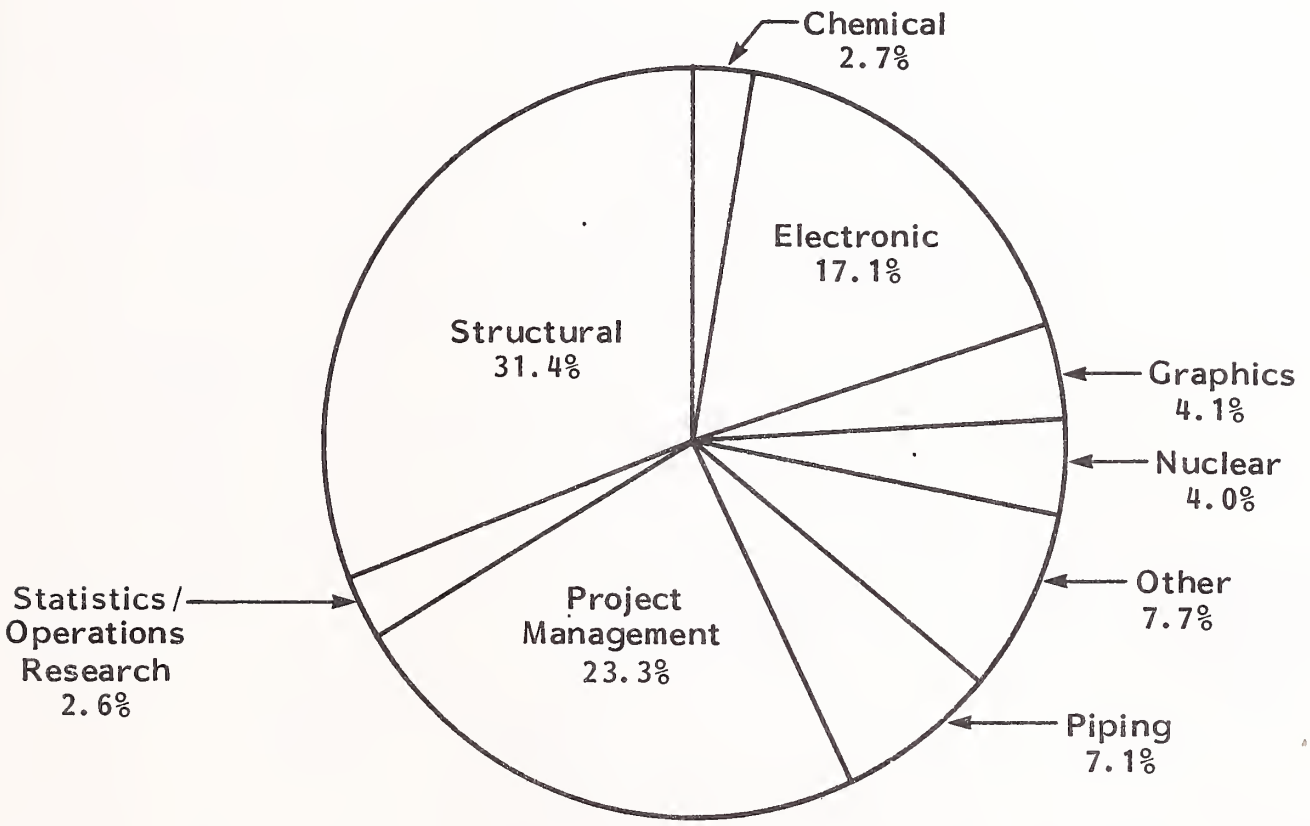


EXHIBIT III-9

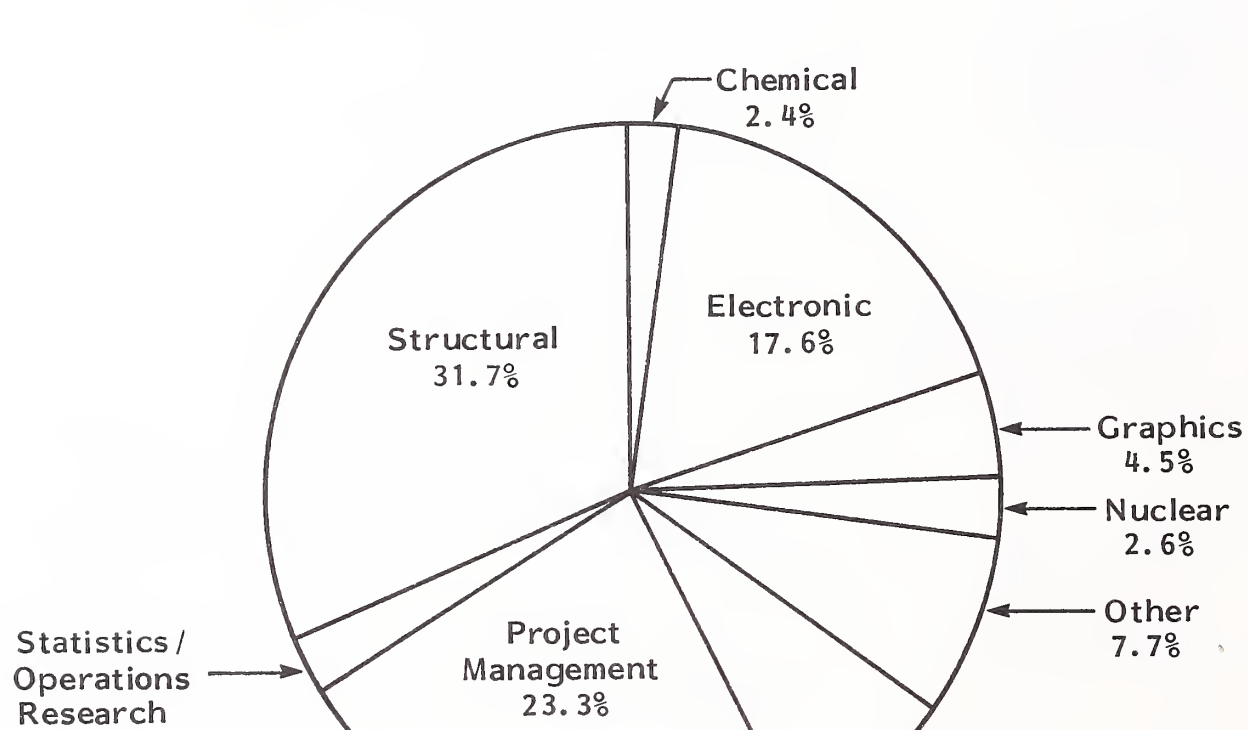
RCS ENGINEERING/SCIENTIFIC MARKET SHARES
BY APPLICATION, 1983




Total Market = $700 Million

EXHIBIT III-10

RCS ENGINEERING SCIENTIFIC MARKET SHARES
BY APPLICATION, 1988




Total Market = $1.3 Billion

such classic applications programs as SYSCAP and SPICE. Also included are electric power distribution programs used by the utility industry. This application will increase its share of the market slightly, to 17.6% of the 1988 market, up from 17.1% of the 1983 market.

4. PIPING

- The fastest growing application is piping analysis, with an AAGR of 16%. Piping is projected to grow from a $50 million marketplace in 1983, to reach $105 million by 1988. At present, piping applications have a 7.1% market share. This is expected to grow to 7.9% by 1988. Listed below are some of the larger piping application programs and their developers:

  - NuPipe - Quadrex.
  - Dynaflex - Intercomp.
  - Triflex - AAA Technology.
  - Pipeline - MCAUTO.

5. GRAPHICS/PLOTTING

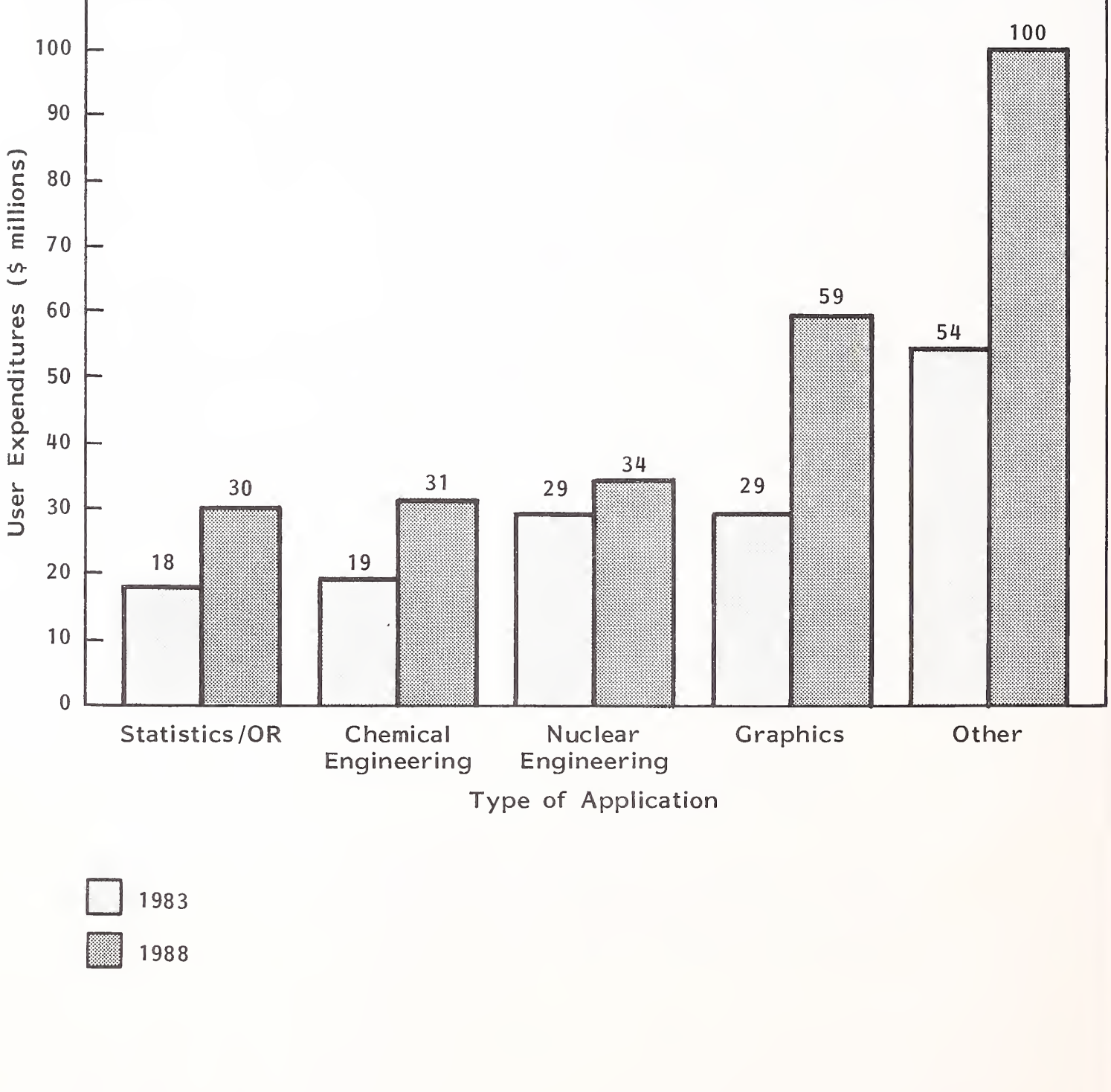
- The second fastest growing application is graphics/plotting, growing from $29 million in 1983 to $59 million in 1988, as shown in Exhibit III-11. This is an AAGR of 15.3%.

6. NUCLEAR ENGINEERING

- The nuclear engineering application market does not have a positive outlook; it will have an AAGR of just 3.2%. Its market size is $29 million in 1983, and it will reach $34 million by 1988.

EXHIBIT III-11

OTHER ENGINEERING/SCIENTIFIC RCS MARKETS, 1983-1988



7. CHEMICAL/PROCESSING ENGINEERING

- Chemical and process engineering applications are expected to grow from $19 million in 1983 to $31 million in 1988, an AAGR of 10.2%.

8. STATISTICS AND OPERATIONS RESEARCH

- Statistics and operations research applications currently have an $18 million RCS marketplace. This is expected to grow to $30 million by 1988, an AAGR of 10.8%.

9. OTHER APPLICATIONS

- Applications contained in the "other" category are those too small to accurately quantify as to market size.

  - Aerospace: Aerospace engineering is a large discipline. The largest consumers of aerospace applications have, however, very large IS data centers that provide most of their computational needs. Indeed, the need is so large that three of the largest aerospace firms (McDonnell-Douglas, Boeing, and Martin Marietta) have spawned three of the largest information services vendors (MCAUTO, Boeing Computer Services, and Martin Marietta Data Services).

  - Civil engineering: The civil engineering application marketplace is too small to forecast accurately and is, because of the modest computational needs of typical civil engineering problems, most susceptible to an in-house computational mode. See Chapter IV for a more detailed analysis.

  - Data base management: The market for engineering data bases is too new at this time to forecast. It is, nonetheless, expected to be one of the fastest growing applications.

- Other applications: Also included in this category are such applications as energy exploration and mechanical engineering. This category is expected to grow from $54 million in 1983 to $100 million in 1988, an AAGR of 13.2%. The growth of this application market is shown in Exhibit III-11.

## 10. DISCIPLINE COMPARISONS

- Commercial services now provide most of the software for engineering and scientific applications, as shown in Exhibit III-12. The only major exception is nuclear engineering with its peculiar characteristics.

- The IS data center is the preferred computing mode, as shown in Exhibit III-13. RCS also has high penetration, especially in structural applications.

- As shown in Exhibit III-14, the next 18 months will see fairly rapid expansion (about 20%) in civil and "other" engineering application expenditures.

EXHIBIT III-12

ENGINEERING/SCIENTIFIC APPLICATION SOURCES

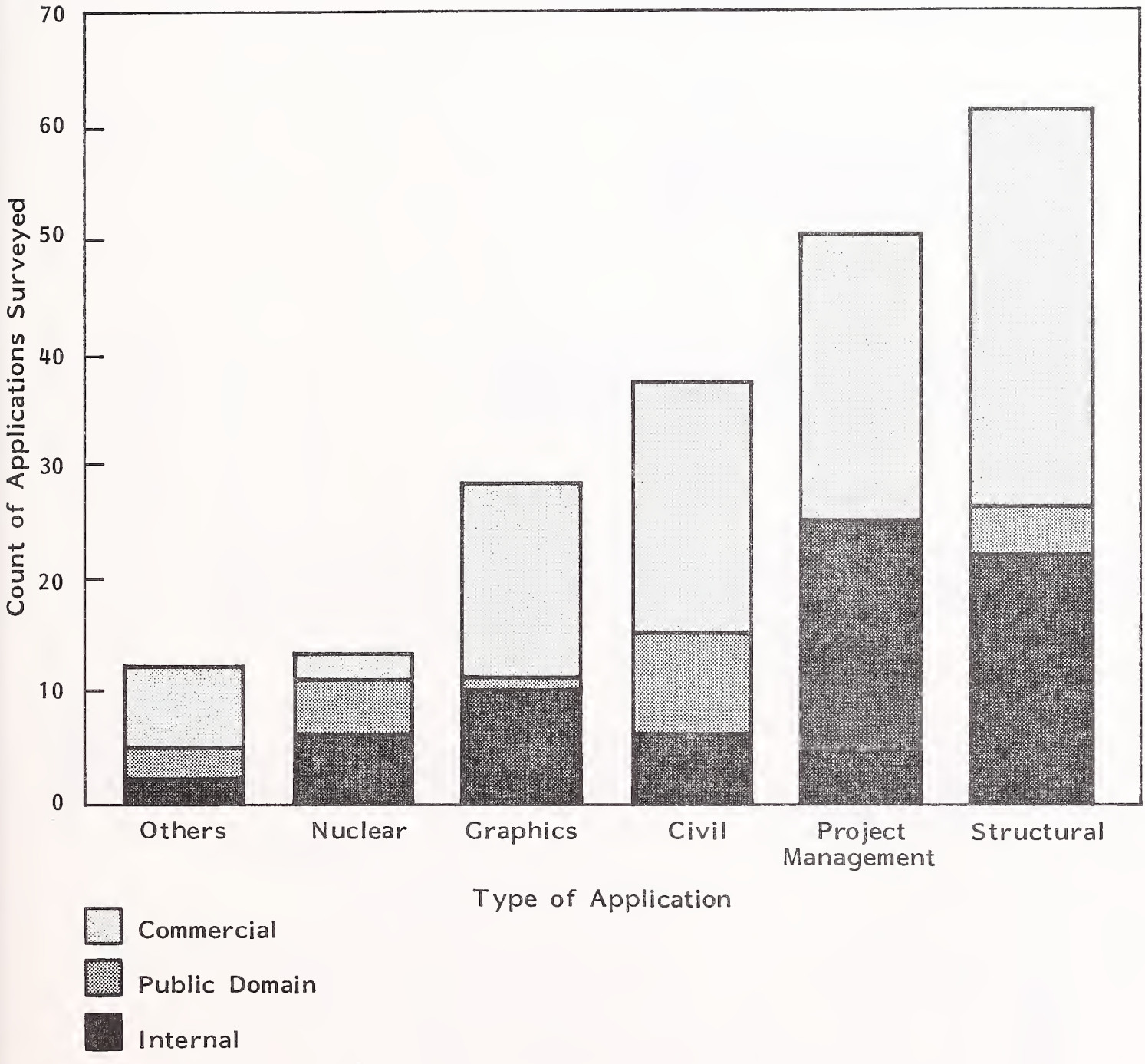


EXHIBIT III-13

ENGINEERING/SCIENTIFIC COMPUTING MODES BY DISCIPLINE

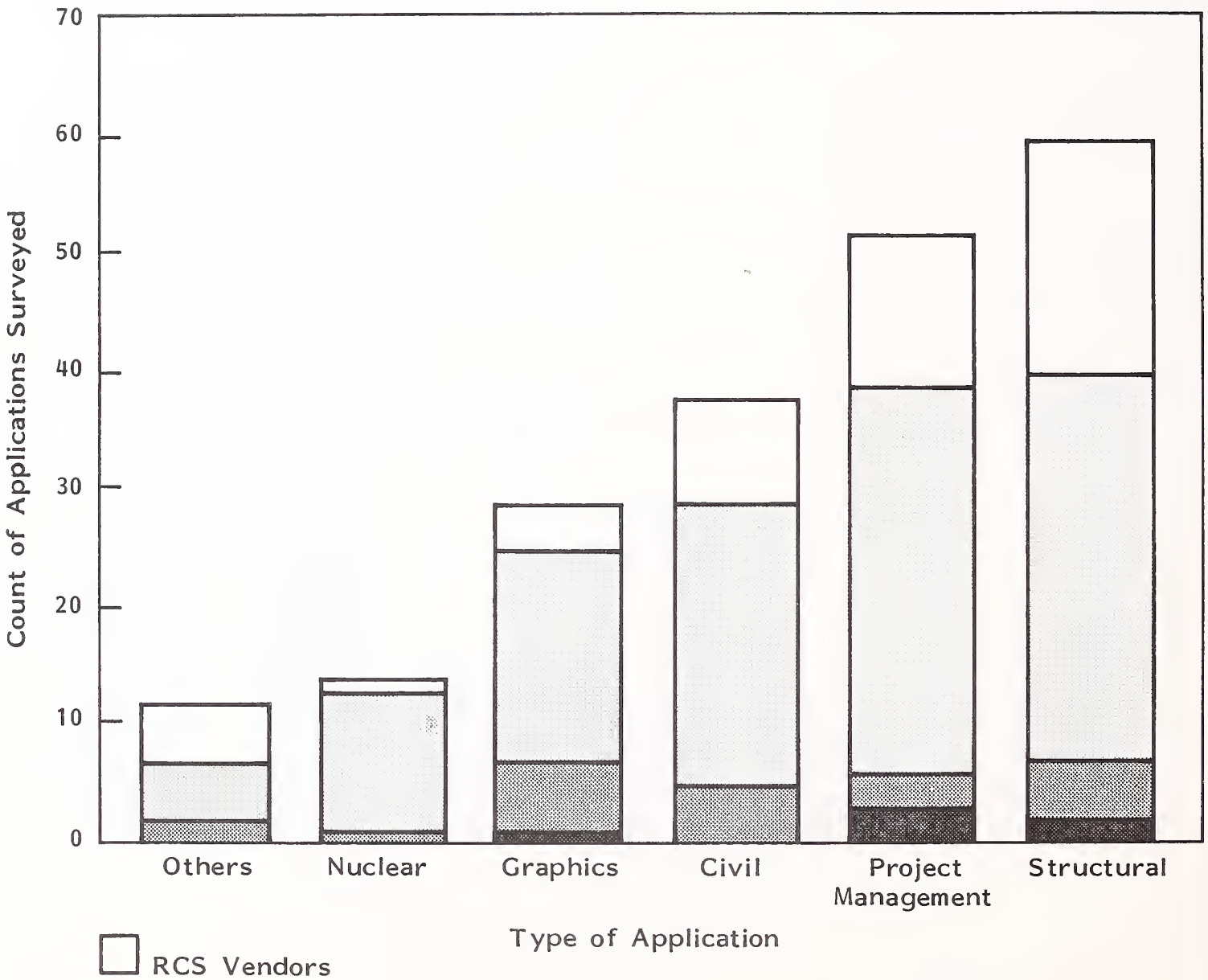
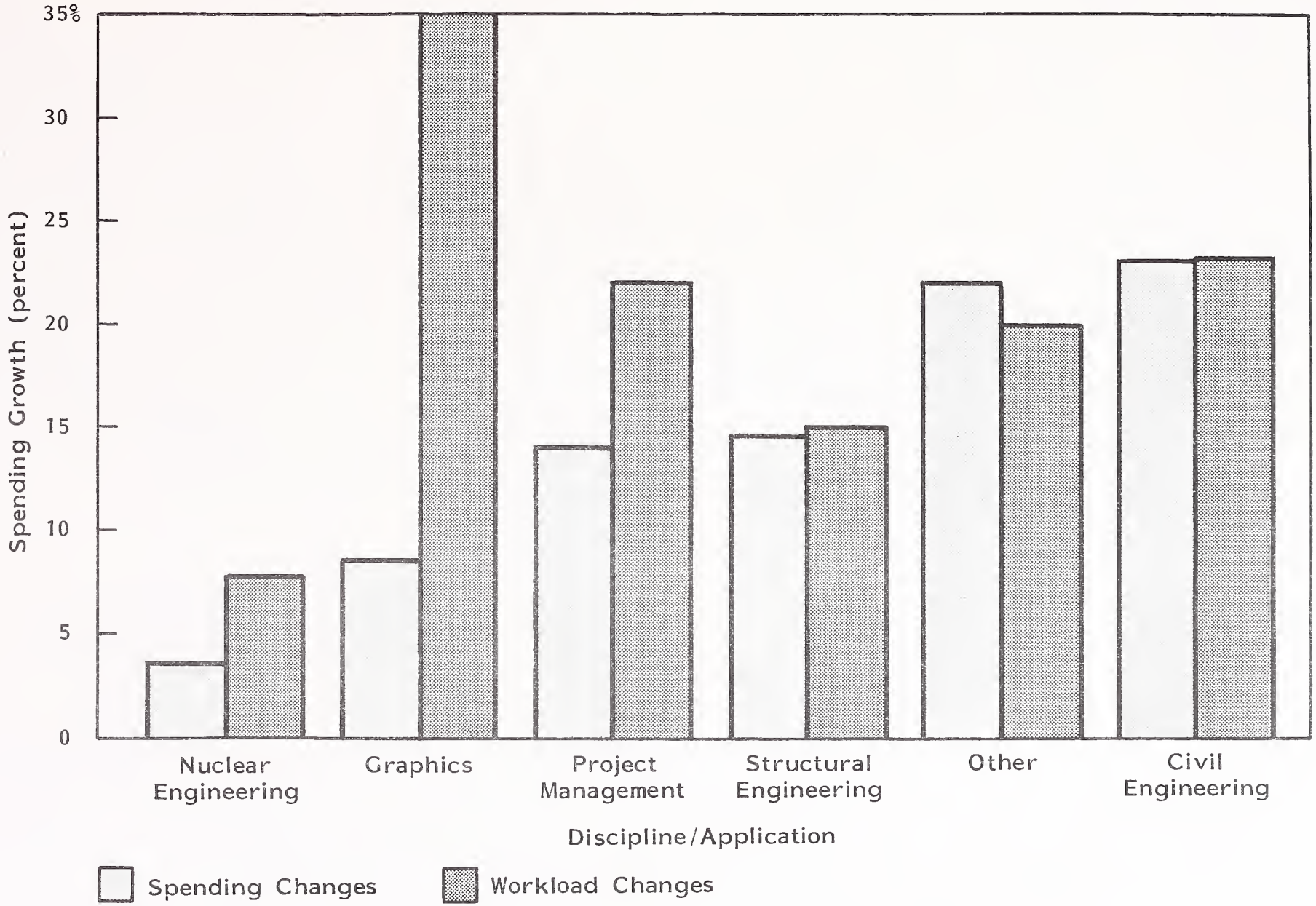


EXHIBIT III-14

CHANGES IN SPENDING AND WORK LOAD
(Next 18 Months)



# IV USER NEEDS FOR ENGINEERING/SCIENTIFIC COMPUTING

# IV USER NEEDS FOR ENGINEERING/SCIENTIFIC COMPUTING

## A. STRUCTURAL ENGINEERING

### 1. INTRODUCTION

- Structural engineering is concerned with the analysis and design of manufactured or constructed structures. A structural engineer typically decides on the size, shape, configuration, and composition of materials necessary for an object to successfully withstand the expected external and internal forces to which it will be subjected.

- These structures can be very small, i.e., gear and bearing design for the internal mechanisms of a fine mechanical watch. Most often, however, structural engineering is used on the design of larger structures - buildings, bridges, ships, etc.

- Historically, many of the structural engineering design techniques support only a static analysis of a given structure. The loads and forces on an engineered object are considered without regard for their variation in time. To compensate for this assumption, a structure is often designed to withstand loads several times larger than those anticipated.

- Increasingly, however, structural dynamics are being considered. The oscillations in a building induced by an earthquake, for instance, are of great

importance. The simplifying assumptions used to avoid considerations of dynamic loads are often costly in terms of materials and construction difficulty.

- The trend in structural engineering, therefore, is to perform more detailed analysis on the structure. Structures are being more highly engineered, less excess material is being used, and more of the expected modes of the structure's behavior are being examined.

- Most of the structural engineering packages mentioned in this report support some form of dynamic analysis.

## 2. SOURCES AND USES OF STRUCTURAL APPLICATIONS

- The study conducted for this report analyzed, among other things, the sources of respondents' structural engineering programs and the uses - the computing modes - in which the programs were used.

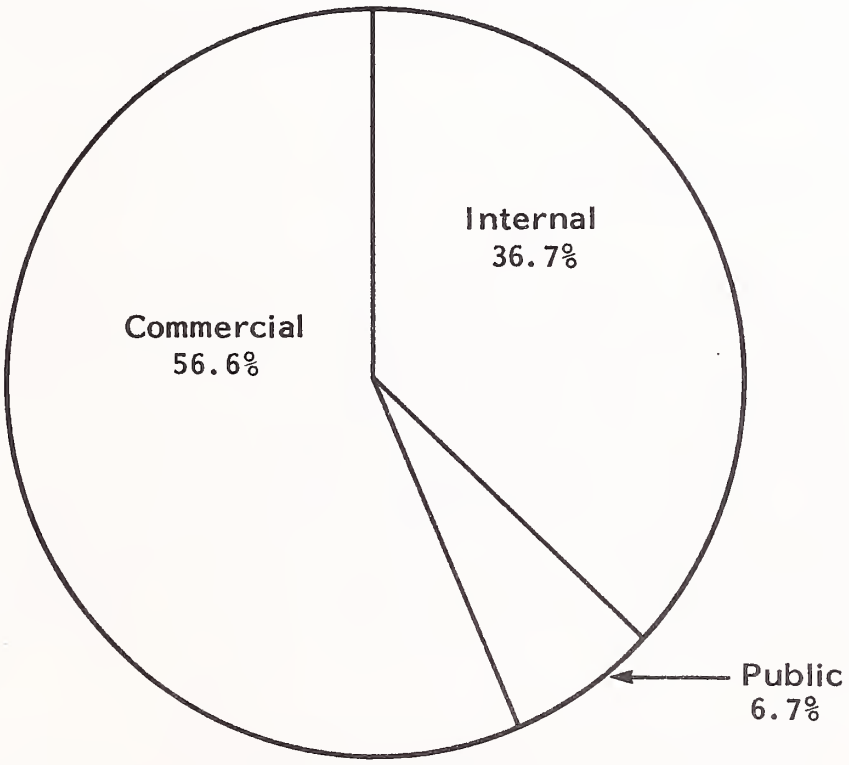
- Structural engineering applications programs are typically very large and complex. It is not surprising, therefore, that most of the structural engineering applications surveyed (56.6%) were from a commercial source, as shown in Exhibit IV-1.

- Slightly more than one-third of the applications (36.7%) were written and maintained by the responding organization. This is significant because it represents a long-term commitment to support a nontrivial software effort. Since the testing involved with software development can be an extensive consumer of computer time, organizations supporting their own structural program may be in need of RCS-based computer facilities.

- The relatively small number of respondents using public domain structural engineering software (6.7%) reflects the fact that the available public domain software is both too old and too simple for modern structural engineering.

EXHIBIT IV-1

STRUCTURAL ENGINEERING APPLICATIONS SOURCES



- The size and complexity of structural design applications virtually mandate a large-scale computer. This was verified by the survey: 88.3% of the respondents used either their IS data center or an outside RCS vendor, as shown in Exhibit IV-2. The one-third market share enjoyed by RCS vendors for this application is the largest in the survey. The size of the applications, their complexity, and the increasing need for more detailed analysis has made structural engineering the largest engineering/scientific application for the RCS industry.

3. KEY APPLICATIONS

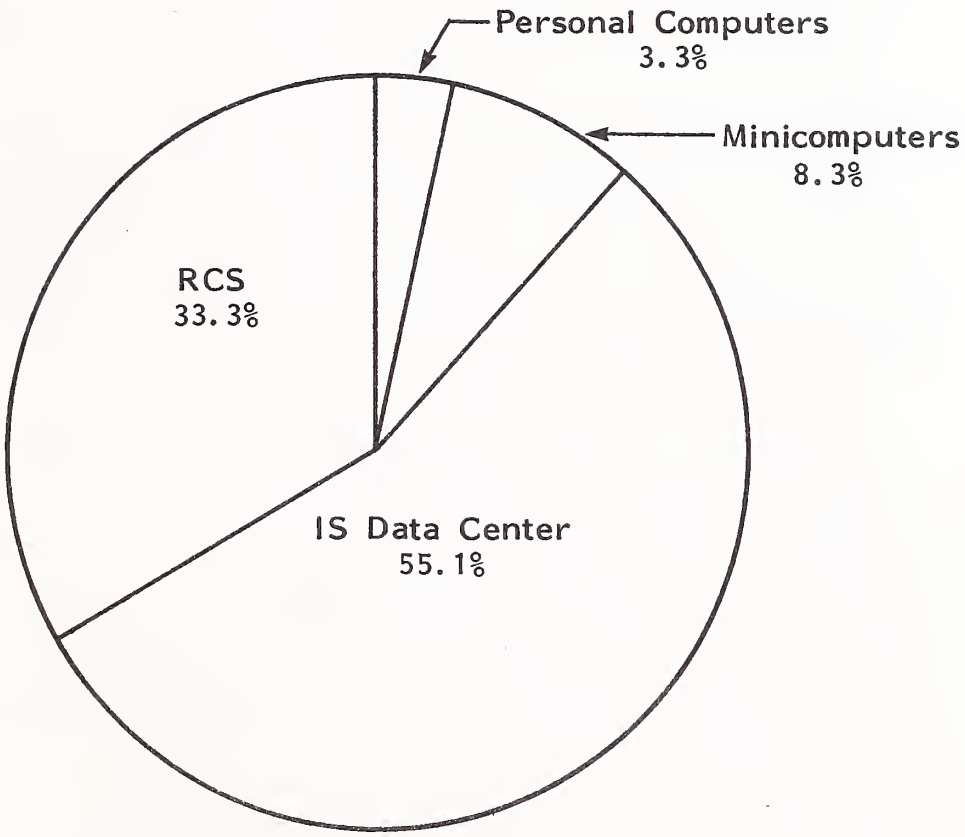
- Finite element analysis is the most widely used of the structural engineering techniques. The structure of an object is conceptually decomposed into a set of simple rods - the finite elements. These elements are assumed to be connected to each other in simple geometric shapes that individually lend themselves to analysis. The geometric shapes are then added together to form the essential structure of the object. Using this technique, the behavior of complex shapes, such as an airplane wing or an automobile fender, can be studied.

- The STRUctural Design Language (STRUDL) is an outgrowth of work done on computerizing engineering techniques at the Massachusetts Institute of Technology in the 1950s and 1960s. The early programs were in the public domain. Several software and RCS vendors have used this code as the basis of their own proprietary offerings. Proprietary STRUDLs offer greatly enhanced capability for analyzing complex structures under a wide variety of conditions. These packages feature automatic model generation, graphics model verification, automatic load generation, complete building code compliance, and member (element) redesign.

  - MCAUTO offers a very popular and widely used version of STRUDL on its RCS service.

EXHIBIT IV-2

STRUCTURAL ENGINEERING APPLICATIONS
COMPUTING MODES



- Project Software and Design, Incorporated (PSDI), has recently greatly expanded their program for structural design. Acceptance and use of their version of STRUDL is therefore increasing.

- The MacNeal-Schwendler Corporation (MSC) supports their version of another public domain structural program, NASTRAN. This program is probably the most widely used, fastest growing, and most widely available of all structural engineering programs. The full-scale program is available from most RCS vendors that support engineering and can be leased by a corporation for use on its own mainframes. In addition, MSC now supports subsets of the program for minicomputers from Digital Equipment Corporation (DEC), Prime Computer, and Apollo Computer.

- In addition to the above, there are a number of widely available and highly respected structural programs in use today:

  - ANSYS - Developed and maintained by Swanson Analysis Systems, Inc.

  - EASE2 - Developed and maintained by Engineering Analysis Corporation.

  - MARC - Developed and maintained by MARC Analysis Research Corporation.

  - STARDYNE - Developed and maintained by MRI.

  - SUPERB - Developed and maintained by Structural Dynamics Research Corporation, a subsidiary of General Electric.

## 4. HARDWARE/SOFTWARE NEEDS

- Although there are a number of high-performance, engineering/scientific-oriented personal computers and minicomputers available, their penetration of this market is slight. As with many other computer applications, the key to the growth of structural engineering lies with the availability of commercial structural engineering software.

- Front-end software needs: The most effective structural application for small computers is acting as a front- and back-end for larger mainframes.

  - There is a substantial computing requirement during the setup of a structural problem. The mesh of finite elements and their connecting nodes can be quite complex and difficult to create properly.

  - After a structural problem has been "solved," a substantial amount of work remains. The analysis of the computed solution with respect to implementation feasibility, cost, and other exogenous factors can be very extensive. This back-end visualization and analysis is also an ideal application for personal and minicomputers.

- The immediate interactive support offered by personal computers and minicomputers makes the use of these computing modes very attractive for the the pre- and post-processing work required in structural engineering. At the present, however, only a few packages are available.

- Small-scale problem software needs: There is a class of structural engineering problems encountered in day-to-day work that can be solved by small computers. These problems are often a simplification of a larger problem for which a "quick 'n dirty" analysis is sufficient. A wide range of software for this type of relatively simple analysis is not presently available.

## 5. MARKET STRATEGY IMPLICATIONS

- The existing structural market is well served by a combination of internal mainframe computers and RCS vendors. The commercially available structural packages have become widely available and are accepted by both engineers and regulatory authorities. The structural offerings available to the typical structural engineer now often include interactive graphics to assist in visualization of the problem. This is particularly true of the major RCS vendors.

- The outlook for this market, therefore, is good. As reported in Chapter III, this marketplace is the largest of the engineering/scientific markets, and growth is expected to remain good, if unspectacular.

- Major RCS vendors serving this market have packaged graphics with structural problem solving to encourage use. This trend is expected to grow.

- Non-RCS use of the major structural applications is expected to grow strongly. The availability of these packages for IS data centers, particularly those with IBM-type mainframe computers, will cause a number of corporate structural engineering departments to acquire the software and move the processing in-house.

- Substantial value is added when an RCS vendor combines structural engineering applications software, quick turnaround mainframe computing, application support, and moderate-cost interactive graphics. The most successful strategy for RCS vendors serving this market, therefore, will be to continue to expand on this packaged approach. The more proprietary content that an RCS vendor can instill in its offering, the more secure will be its business base.

- The opportunities for RCS vendors who do not already have a substantial presence in this marketplace are few. The expenses necessary to install a

suite of structural software, hire and train a cadre of support personnel, and package these offerings with graphics would be high, and marketplace penetration would be slow.

- Cost-conscious RCS customers may offer a specific market, however. If an RCS vendor has one or more substantial customers who wish to use a specific piece of structural engineering software, and if they are willing to provide their own support, then the software can be acquired and installed with relatively little risk. Care must be taken, however, that support and other high-expense requirements do not creep in due to customer (and, most often, potential customer) demand. This is a simple extension of the "computer utility" strategy pursued by some RCS vendors.

## B. CIVIL ENGINEERING

### 1. INTRODUCTION

- Civil engineering deals with the analysis and design of civil projects - dams, highways, waterways, and the like. A civil engineer conducts surveys, analyzes soil and rock conditions, plans the "cut" necessary to site a building, specifies needed drainage improvement, etc.

- Civil engineering is not so much a set of scientific disciplines as it is a collection of engineering practices. Following are some of the areas generally covered by civil engineering:

  - Hydrology and water management: This area covers the movement and management of water - storm drains and sewers under normal and adverse conditions, flood control measures, water surface profiles, dam safety factors, etc.

- Land management: Land management covers the geometric problems associated with the design of highways, waterways, railways, and subdivisions.

- Soil mechanics: This aspect of civil engineering deals with how the soil in a given location will react. Included are earthquake analysis, building and structure siting, subgrade improvement specifications, and embankment design.

- Urban engineering: Urban engineering covers traffic flow, building and facility capacities, transportation simulation, parking studies, and general urban planning.

- Environmental studies: Environmental studies includes the preparation of environmental impact studies and noise abatement planning.

- Civil engineering is not inherently computer intensive. Although there are projects and problems that can require large-scale computing, many of the problems addressed by civil engineering can be solved by a calculator or small computer.

- Civil engineers were among the first to use computers to assist with drafting. The layout of a subdivision, with its complex of sewers, roads, power and telephone lines, and building sites, is ideally suited for computerization.

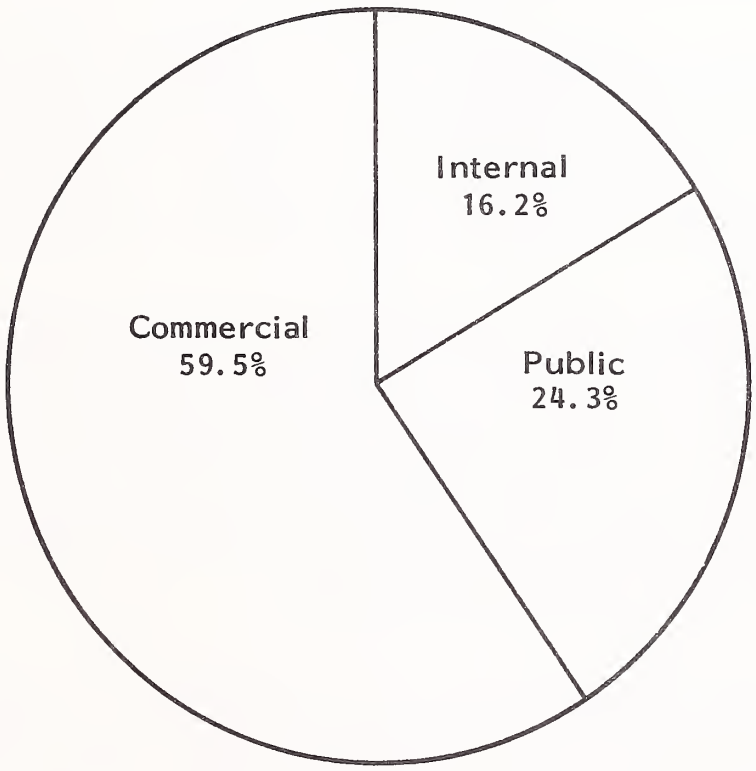
## 2. SOURCES AND USES OF CIVIL ENGINEERING APPLICATIONS

- Most of the applications surveyed (59.5%) were commercially prepared, as shown in Exhibit IV-3.

- A substantial portion of the applications surveyed (24.3%) were programs obtained from the public domain. This relatively large proportion is to be

EXHIBIT IV-3

CIVIL ENGINEERING APPLICATIONS SOURCES



expected because, by its nature, civil engineering often involves governmental agencies. The Army Corps of Engineers in particular has contributed many programs that are in widespread use.

- The availability of commercial and public programs has discouraged the internal development of civil engineering codes. Only 16.2% of the applications surveyed were internally coded.

- Many of the survey respondents gave a rather surprising reply when queried about their computing mode for civil engineering problems: they did not use computers. This result indicates that common civil engineering problems are simple and can be solved with a programmable calculator, for instance.

- Given the above results, one would expect that the smaller end of the computing mode spectrum (personal computers and minicomputers) would be employed in a substantial portion of the problems that were computerized. This was not true, however. No civil engineering applications were found for the personal computer mode, and only 13.2% of the applications were using minicomputers, as shown in Exhibit IV-4.

- INPUT believes that this fact merely reflects the immaturity of the personal computer marketplace and not a lack of need. Indeed, INPUT expects that many of the civil engineering codes and practices will be successfully converted to run on both personal computers and minicomputers.

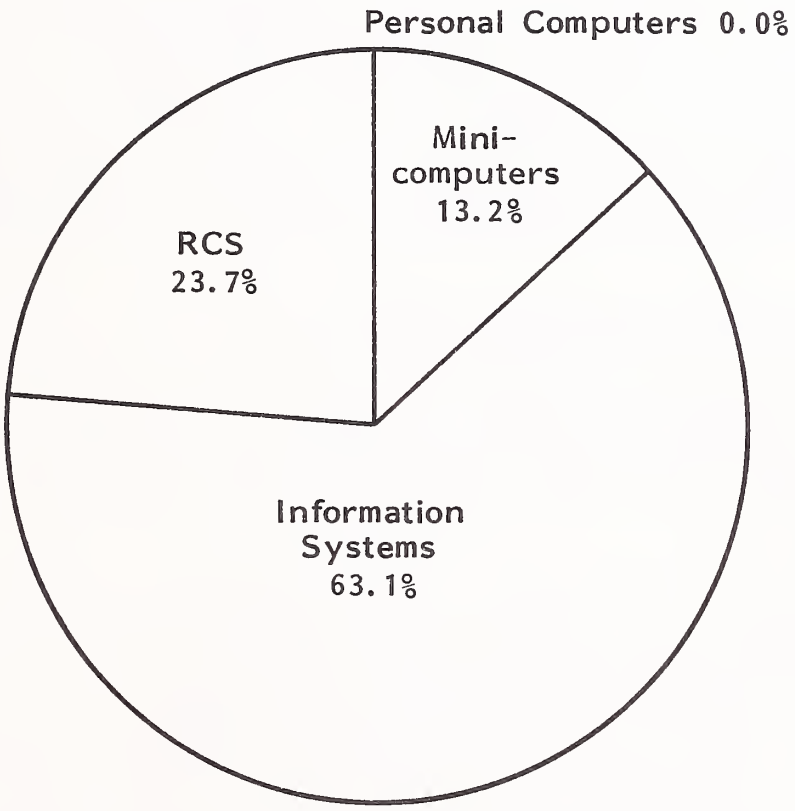
- Almost two-thirds of the applications surveyed (63.1%) used the in-house IS data center for their computing mode. Slightly less than one-quarter (23.7%) used RCS vendors for their civil engineering applications.

3. KEY APPLICATIONS

- Hydrological studies and geometric programs are the most frequently used civil engineering computer applications.

EXHIBIT IV-4

CIVIL ENGINEERING APPLICATIONS COMPUTING MODES



- Many hydrological programs are available from the U.S. Corps of Engineers at the Hydrologic Engineering Center (HEC). These programs in the HEC series are used in computing hydrographic and dam safety, water surface profiles, flood flow frequency, etc.

- The COordinate GeOmetry (COGO) program, originally part of the MIT ICES series, is the most widely used geometrical program. The system contains a set of processing routines, data files, and a user language that assists in the solution of geometric problems. One of the enhancements offered by many commercial versions is expanded plotting and graphics capabilities.

## 4. HARDWARE/SOFTWARE NEEDS

- Civil engineering computer applications are relatively modest consumers of computing power when compared to some of the other disciplines' applications.

- Many of the common civil engineering packages require a plotter or other graphical output to be effective. Land management problems or subdivision layout tasks, for instance, must have a plotter or graphics device available. At the present time the major civil engineering application packages support only those devices found in major data centers - centers run by RCS vendors or part of an IS data center.

- Because of the small size of the civil engineering marketplace, no software or RCS vendor has moved to dominate it.

- INPUT expects that one or more engineering/scientific software vendors will recognize the opportunity in the civil engineering marketplace and will come forth with a package of vertical civil applications that will be operable on a range of small computers. If correctly interfaced with graphics and plotters, this offering could become widely used.

## 5. MARKET STRATEGY IMPLICATIONS

- The civil engineering market has several implications for providers of information services.

- The size of the market does not warrant a dramatic expansion in services offered by an RCS vendor. Those firms who have a market position may profitably serve the market with their offerings. Organizations that do not already have a sizable market share will probably find it diffiult to penetrate this marketplace and will probably find the profit margins thin.

- The market is not well served with software for the smaller computing modes. Firms with expertise in civil engineering software and personal or minicomputers may wish to adapt some of the mainframe products to this area.

- There are approximately 24,000 U.S. engineering firms that employ fewer than 50 people. Most of them are small shops with just a few engineers. An integrated systems offering would be well received by this market. A system of this type should include the following:

  - Civil engineering software: A variety of civil engineering software should be available to serve the specialties of the target firms. Included should be programs in hydrology and water management, land management and surveying, and soil mechanics.

  - Scientific utility software: To assist these smaller firms in utilizing such an integrated offering, it will be imperative to offer a complete set of engineering utility and systems software.

  - Included should be a FORTRAN compiler, a graphics package, a text and program editor, and a FORTRAN debugging package. Teleproces-

sing software that allows the computer to act as a remote workstation or terminal for the RCS vendors is also desirable.

- High-speed microcomputer: To serve even the modest computational needs of the small-scale civil engineering market, one of the new high-speed, large word size microcomputers should be used.

- Candidate processors include the Motorola 68000 and the Intel 8086 when coupled with the 8087 numeric coprocessor. Convergent Technologies of San Jose and Apollo Computer of Chelmsford, Massachusetts, offer computers of this class.

- Peripherals: Although a floppy-disk-based system may be offered as a bottom-of-the-line product, a systems integrator should expect to offer a range of high-capacity, hard-disk drives. A provision should also be made for a variety of plotters.

## C. NUCLEAR ENGINEERING

### 1. INTRODUCTION

- Nuclear engineering is a scientific discipline with an industry orientation.

- Many nuclear engineering problems are related to particle physics. Problems in core analysis, radiation shielding, and reactor safety are parts of nuclear engineering.

- Many other nuclear engineering problems, however, are solved by structural, mechanical, and civil engineering codes. While the construction of a nuclear reactor's core, for instance, involves problems unique to nuclear engineering, other portions of the design process may utilize standard structural and thermodynamic codes.

- Nuclear engineering is unique in the amount of regulation and inspection to which its practitioners are subjected.

  - Firms working on a nuclear project must keep meticulous records. The firm must be able, years later, to replicate the design work and specify the individuals originally involved.

  - As previously noted, software that is used in the design and analysis of nuclear projects must be certified by the Nuclear Regulatory Commission.

## 2. SOURCES AND USES OF NUCLEAR APPLICATIONS

- The codes used in nuclear engineering are often in the public domain. In fact, a higher proportion of nuclear engineering applications were from this source than from any other engineering discipline surveyed (38.4%), as seen in Exhibit IV-5. This is due to sponsorship of studies by the federal government and semipublic agencies like the Electric Power Research Institute (EPRI).

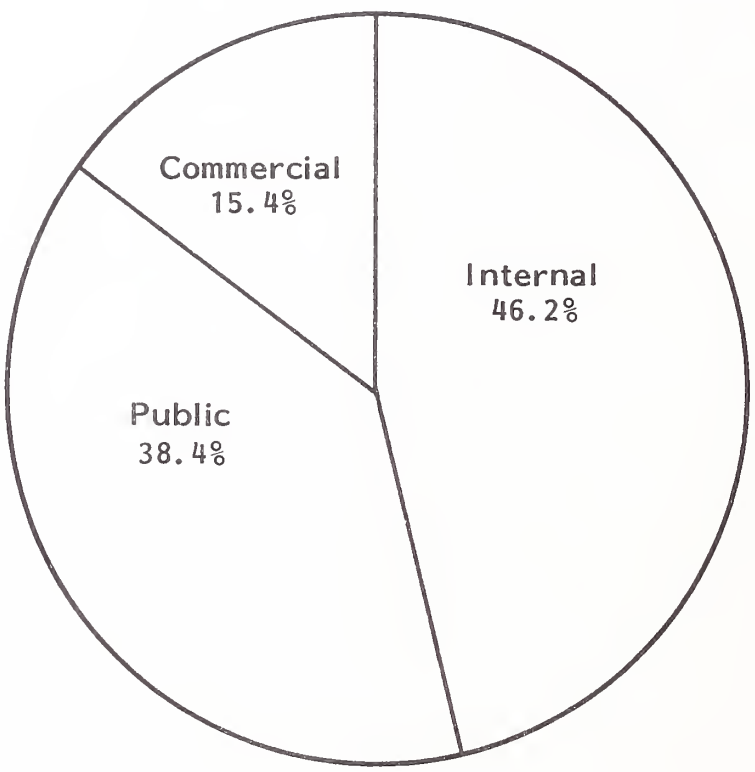
- The largest source of nuclear applications among respondents was internal development (46.2%).

- Only 15.4% of their nuclear engineering applications were from commercial software sources. This is a consequence of the robust public domain nuclear software activity and the heavy, almost oppressive burden of regulation and certification that commercial nuclear software developers must endure.

- Some nuclear engineering software consumes monstrous amounts ofcomputer time to reach a solution. A compute-bound code running for several hours on a large-scale processor is not unusual. As a consequence, virtually all of the applications surveyed used an in-house computing mode - using even the least expensive RCS vendor would be too costly.

EXHIBIT IV-5

NUCLEAR ENGINEERING APPLICATIONS SOURCES



- The largest share of the applications (85.7%) were running on the IS data center, as shown in Exhibit IV-6. This s consistent with the need of nuclear engineering for large-scale processors.

- RCS vendors held only a small fraction of nuclear engineering processing (7.1%). Project and budget cutbacks have squeezed costs so that only occasionally can an engineering firm afford to utilize outside computer services.

3. KEY APPLICATIONS

- Most of the applications that our respondents were using on nuclear projects in fact belonged to other disciplines.

  - Structural engineering: Applications frequently reported included NASTRAN, STRUDL, STARDYNE, and ANSYS.

  - Piping: One of the respondents' most frequently cited applications was piping. There is more piping work done on a nuclear project than on a nonnuclear power plant project because of the variety of fluids that are used. Most frequently reported application products were TRIFLEX, NUPIPE, COMPAID, and MCAUTO's PIPELINE.

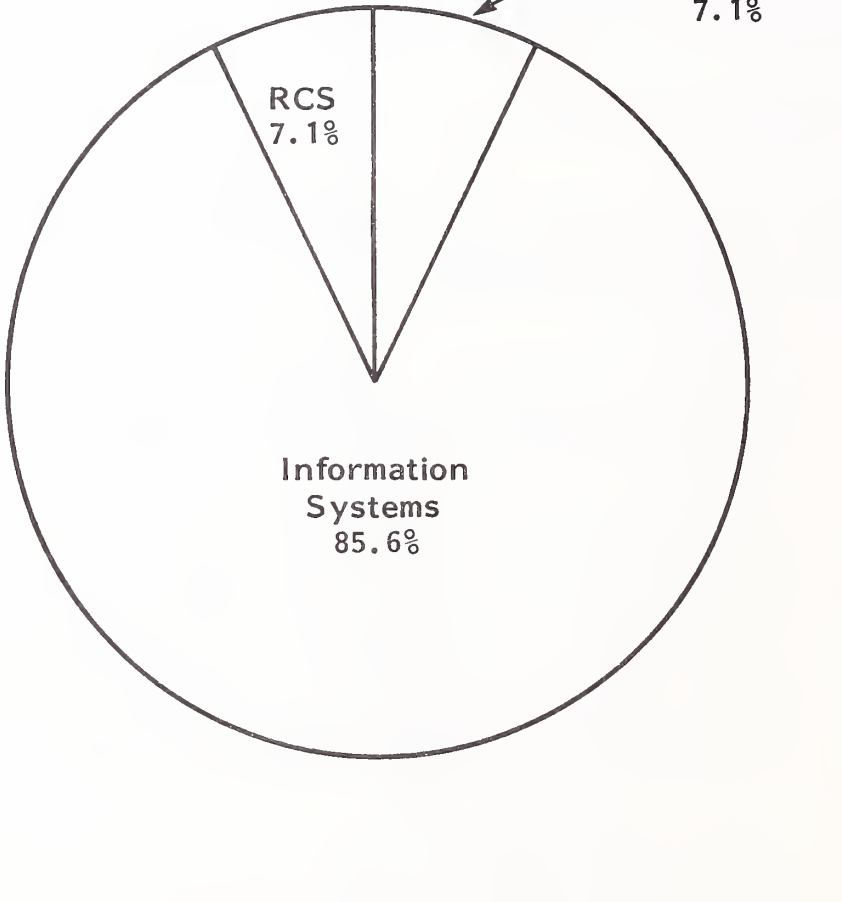
  - Project Management: Due to the very high cost and extremely long lead times, nuclear projects are subject to more project management scrutiny than other projects. While our respondents often construct in-house nuclear project management software, they also reported using MSCS and PROJECT/2.

- There are two categories of applications unique to nuclear engineering:

  - Reactor design: These applications programs solve problems in core analysis, design, and radiation safety. Due to the current low level of

EXHIBIT IV-6

NUCLEAR ENGINEERING APPLICATIONS COMPUTING MODES



design activity, only a few codes were mentioned by our survey respondents in this area. These included SDC and CITATION.

- Nuclear simulations: The nuclear industry is one of the largest users of simulation technology. Nuclear simulations typically model either short- or long-term loss of coolant accidents (LOCA). RELAP4 and RELAP5, as well as CONTEMPT-LT are applications specifically written for these simulations. General-purpose simulation languages such as WATSIM and SIMSCRIPT are also frequently used to model the behavior of nuclear plants and projects.

- Simulations are particularly important for RCS vendors because of the way that simulation models are constructed. Typically a simple model is built and operated (tested) to generally verify correct behavior. Complexity is then added to study individual areas of the problem in more detail. When a working model is finally constructed, it is frequently run many times to allow the engineers to understand various phases of the project's operation. The iterative nature of model contruction, when combined with a high-use rate, make simulations a particularly attractive RCS application.

## 4. MARKET STRATEGY IMPLICATIONS

- Because new nuclear design activity is relatively low and because the long-range outlook for increased nuclear power plant construction is poor, INPUT cannot recommend increased effort in this area.

- Vendors with substantial business in this area should prepare themselves for a "flat" market and should expect the following conditions:

  - Keen price competition.

  - Profitability squeeze.

- RCS vendors should therefore carefully examine their expenses in support of nuclear engineering.

- Applications and support offerings that are now not profitable, or those that are earning substandard profits, cannot expect a growing market to offer a bright future.

- Of the unique nuclear engineering applications, nuclear simulation appears to be the most promising for RCS vendors. Several nuclear firms in our survey reported their intention to do most of their business in the reanalysis and redesign of nuclear projects.

## D. PROJECT MANAGEMENT

### I. INTRODUCTION

- Project management offers a unique blend of engineering/scientific analysis and the application of good business practice.

- Project management typically employs the critical path method (CPM) or the project evaluation and review technique (PERT) to analyze the network of activities that constitute a project.

- Each discrete activity within a project must be analyzed with respect to the relationships it has with other activities in the project. These relationships and other activity data (including expected duration, resource requirements, and costs) are then entered into one of the available scheduling applications packages.

- These applications packages then apply scheduling algorithms to allocate manpower, equipment, and material resources for priority use. The advantage

to the user is that he can iron out potential problems on the computer, not on the job site.

- Due to their long duration and high cost, construction and engineering projects are the major consumers of project management applications. But this is not their only use; project management applications are also used to monitor and control a variety of projects in different industries. The following is a partial list of project management applications:

  - Office building construction.
  - Nuclear power plant outage.
  - Weapons system development.
  - Factory production line changeover.
  - Software development.
  - New product introduction.
  - Facility moves.
  - Equipment installation.
  - Research and development.

- Currently available, commercial project management applications software and services are economical only for large projects. An industry rule of thumb is that the cost of a construction project must be at least $100 million to warrant use of this technique.

## 2. SOURCES AND USES OF PROJECT MANAGEMENT

- Most notable about project management applications is the complete absence of any public domain programs in the survey, as shown in Exhibit IV-7.

- Most public domain software comes from research conducted by colleges and universities. The "publish-or-perish" philosophy provides pressure to conduct the programming research, and the constant supply of graduate students provides a source of inexpensive, skilled labor. But, because project management techniques are not properly an engineering/scientific discipline, the academic community has not been active in this area.

- One-half of the applications surveyed were from commercial sources. This relatively high concentration of commercial applications is due to several factors:

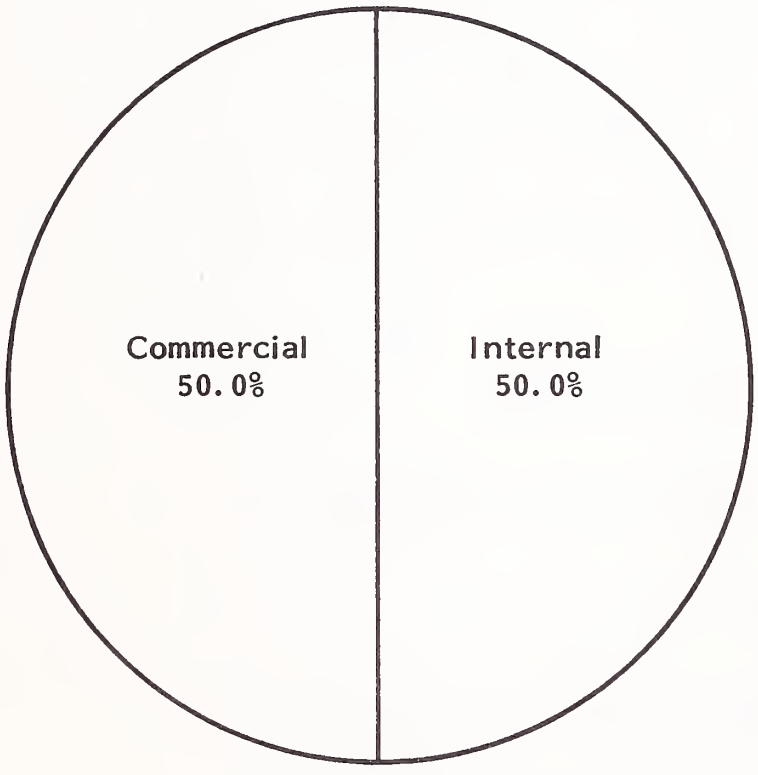
  - Network scheduling software is difficult to write. The algorithms used to schedule an activity network are not well known, and they demand a high degree of computer skill to apply.

  - Project mangement systems are very large. Because they are used to manage large, costly projects, user requirements for project management systems are very demanding and comprehensive.

- One-half of the applications surveyed were developed internally by the survey respondents' programmers or engineers. Many of the firms surveyed developed these internal applications because of the relatively high cost of commercially available project management software. There were other respondents that had a continuing need for management and reporting in a specific area of project management not covered by commercial systems. One firm, for instance, reported writing a nuclear fuel cost-tracking system.

EXHIBIT IV-7

PROJECT MANAGEMENT APPLICATIONS SOURCES




Public 0.0%

- Only a few of the reported project management applications were running on personal computers (5.8%), as shown in Exhibit IV-8. This reflects the fact that very little project management software is available for personal computers.

- The in-house IS data centers again captured the majority of the project management applications surveyed (63.4%). In many cases the reported application was written in-house to satisfy particular needs and did not perform activity network scheduling, as do most of the commercial programs. Indeed, applications in this area are more typical of routine data processing (with a regular schedule of inputs, processing, and output reports) than they are of regular engineering/scientific computing. Some reported applications included:

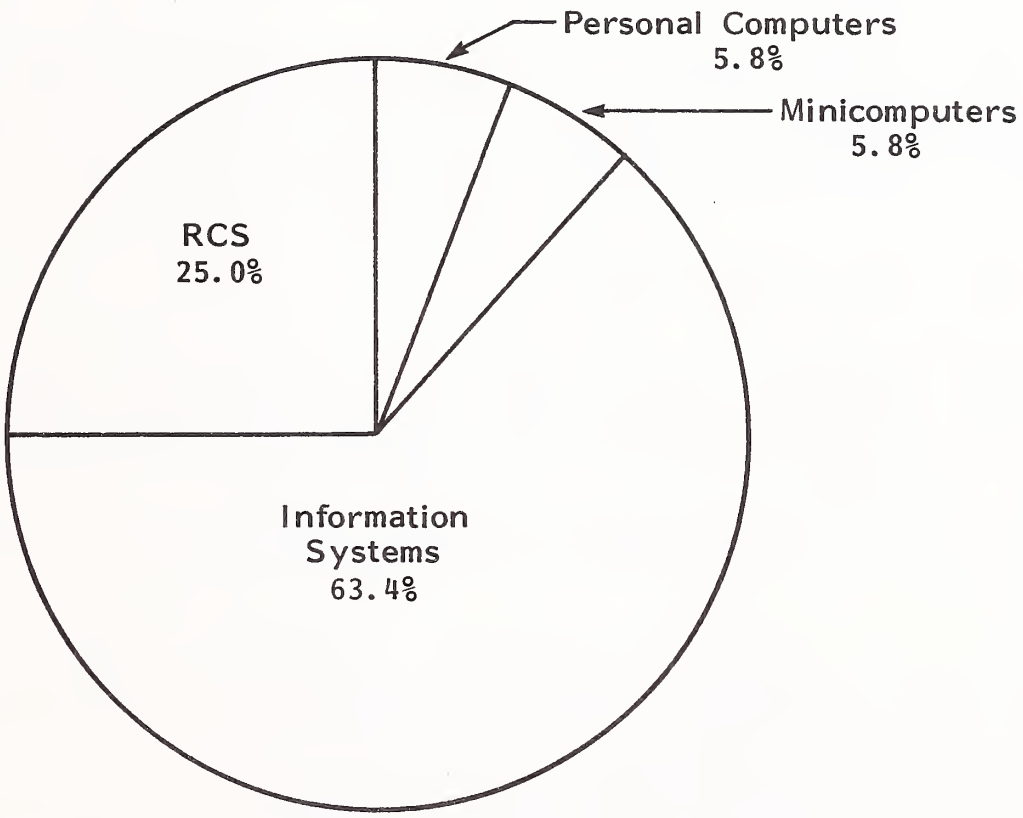
  - Man-hour distribution.
  - Project cost accounting.
  - Task scheduling.
  - Nuclear power plant outage control.
  - Payment estimation.

- The RCS computing mode was used by 25% of the survey respondents. This excellent penetration rate by the RCS mode is due to several factors:

  - Project orientation: A firm will often use outside services to satisfy its project management needs because the project being managed is a relatively short-term or low-level one that cannot justify software and/or hardware acquisition.

EXHIBIT IV-8

PROJECT MANAGEMENT APPLICATIONS COMPUTING MODES



- Applications assistance: Many firms are unfamiliar with project management techniques and therefore look into their RCS vendors to provide support and training for project management.

- Quick response: The RCS computing mode provides instant access without incurring lasting obligations.

- Although project management applications are ideally used throughout a project's life to provide continuous progress feedback, there is a tendency to use the technique only at the project's inception and sporadically thereafter.

3. KEY APPLICATIONS

- Personal computing mode: Project management systems are available for personal computers. These systems are typified as follow:

  - Low cost: Prices range from $200 to $500 per package.

  - Limited network size: The size of the network that can be scheduled is usually quite limited; 100-200 activities is the maximum.

  - Limited capabilities: Packages in this area offer a limited set of capabilites. They will, for instance, schedule a network according to earliest start date and offer simple reports. Some including primitive cost data. Not currently available are features such as graphics output, resource scheduling, sophisticated calendaring, optimization of resource use.

- These packages are suitable when the project to be scheduled is relatively simple and the need for advanced features is nil. Their chief advantage is their low cost.

- Although these systems might be used by some engineering/scientific departments to perform simple, preliminary schedules, most engineering/scientific applications of project management are too large.

- While there are more than 10 personal computer scheduling packages currently available, one system has become especially popular: VisiSchedule by VisiCorp.

- Integrated systems: Project management software is being integrated with popular minicomputers and is being offered in increasing numbers. These systems offer increased features at an increased price:

  - Moderate cost: The most popular computer for this delivery mode is a member of the VAX family manufactured by Digital Equipment Corporation. Prices for these systems range from a minimum of $80,000 to over $300,000. Some vendors, most notably Project Software and Development Incorporated (PSDI), offer only a lease/rental agreement.

  - Large network capacity: The size of the activity network that can be manipulated is often not limited by the software. The speed of the computer may present practical limits on how many activities can be scheduled

  - Increased capabilities: Depending upon system, vendor, and price paid, these systems may be purchased with some of the most sophisticated features found on the mainframe applications. Again, the size of the CPU or the speed of the peripherals often limits usability.

- Integrated systems offer an attractive combination of modest price with advanced features and capabilities. They have another distinct advantage: because they are single-purpose machines, they can be sent to the project site itself. In this way critical elements of a project can be monitored and rescheduled in a near real-time manner.

- Although generally excellent for even very large, single projects, these machines are not well suited for corporationwide project management.

- There are a number of integrated project management systems available. Three of the leaders are:

  - Artemis by Metier.

  - Project/2 Machine by PSDI.

  - PACI by AGS Management Systems.

- RCS and SI data center computing modes: Project mangement software has been available since the late 1960s. Since then the surviving applications have become ever more sophisticated and capable. Typical systems parameters include the following:

  - High cost: The effective minimum cost for a moderate-sized project regularly using an RCS system will be more than $2,000 per month. Prices increase sharply with the size of the network managed and the frequency of the access. A large, much-used network, as is frequently encountered in a nuclear power plant outage, can cost more than $100,00 per month. Full-scale project management applications packages generally cost more than $75,000, sometimes much more. PSDI does not sell their Project/2 package, but instead rents it by the month.

  - Unlimited network size: In addition to having no constraints on the size of the networks that can be manipulated, mainframe software may be utilized to provide corporationwide resource leveling and scheduling.

- Advanced features: Packages offered for in-house use or through RCS vendors offer very sophisticated costing facilities, multiple calendars, and a variety of report and graphics options.

- Systems of this type are capable of fulfilling almost any project management need. They have a full range of features and capabilities that deliver impressive cost and time savings for the using firm, but at a high price.

- The leading project management software includes the following:

  - PAC3 by AGS Management Systems. (Newly acquired by AGS Computers, Inc., this firm was previously known as Atlantic Management Systems.)

  - Project/2 by PSDI.

  - Management Scheduling and Control System (MSCS) by MCAUTO (available only through MCAUTO's RCS offering).

4. MARKET STRATEGY IMPLICATIONS

- The market for project management systems has been growing and expanding ever since PERT was invented for the Polaris submarine project. Computerized project management is gaining increasing acceptance as a management tool. It is being employed in a variety of projects, large and small.

- Use of project management software on a personal computer is likely to only whet a corporation's appetite for the technique. A regular series of seminars and product education sessions is an effective way to tell potential customers what they are missing.

- The need for user support and training is unusually high with project management applications. This is due to the following factors:

- Project management techniques are new to most customers. Since it is an outgrowth of operations research, very few individuals, including engineers and scientists, are educated in project management.

- The major software packages are very sophisticated. As the sophistication of the software increases, the need for user support, education, and training increases also.

- Many RCS vendors have offered project management software but have failed to provide adequate training and user assistance.

  - Disgruntled users frequently switch vendors in search of better support.

  - Those that do remain often underutilize the system and thereby lose revenue.

- To compete successfully in this market, therefore, an RCS vendor will need to maintain a dedicated project management staff.

- All project management mainframe software now supports the generation of a precedence diagram. The location of the plotter, relative to that of the customer, therefore becomes very important. Those RCS vendors intending to actively market project management services might well consider establishing satellite plotting stations in selected branch offices.

## E. GRAPHICS/PLOTTING

### 1. INTRODUCTION

- In recent years the use of computers to generate charts and graphs has grown substantially. This is a result of major reductions in the cost of computers and graphics output devices, the increased use of computers for data handling, and the availability of high capability graphics software.

- Non-CAD/CAM graphics is increasingly being integrated into the applications programs that are generating the data to be plotted or graphed.

- This integration trend is so strong that most of the graphics being generated by the surveyed RCS vendors now comes from applications packages' graphics routines.

### 2. SOURCES AND USES OF GRAPHICS

- The great majority of graphics/plotting applications were from commercial sources (60.7%), as shown in Exhibit IV-9. This is the highest proportion of any application surveyed. The major reason is because graphics/plotting software is difficult to write.

  - The intended output is visual, but the medium - the code - is not.

  - Graphics output devices are notoriously individualistic. What worked for one may produce very different results for another.

- Only 3.4% of the surveyed applications were running on personal computers, as shown in Exhibit IV-10. This is more a reflection on the general lack of engineering/scientific applications in this mode than on a lack of personal computer capabilities.

EXHIBIT IV-9

GRAPHICS/PLOTTING APPLICATIONS SOURCES

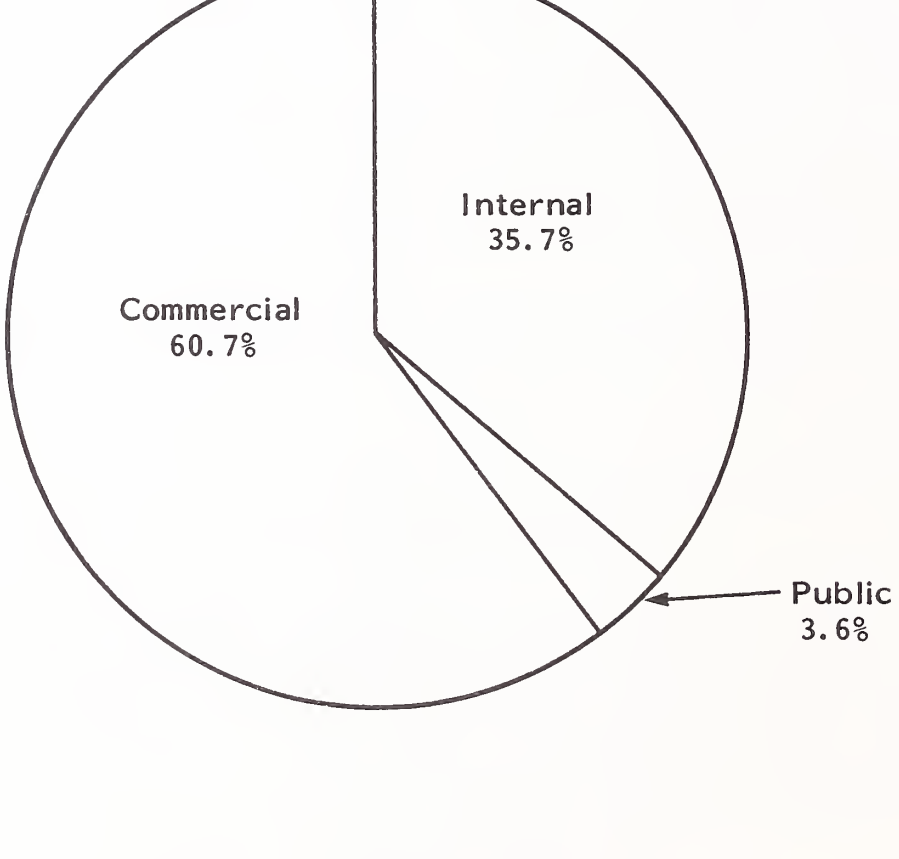
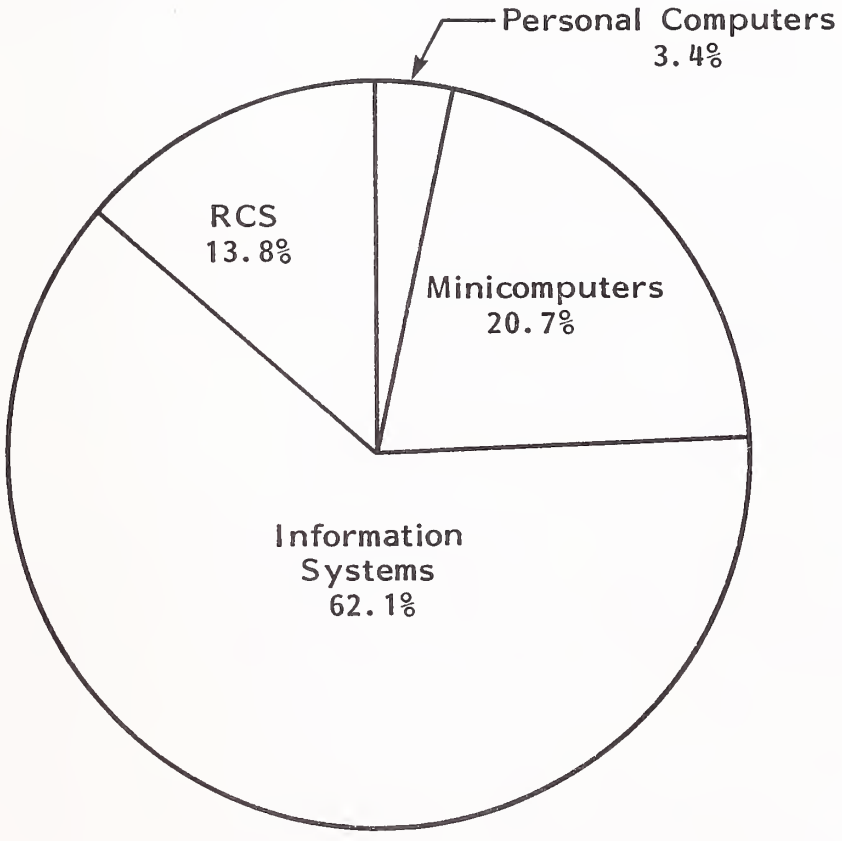


EXHIBIT IV-10

GRAPHICS/PLOTTING APPLICATIONS COMPUTING MODES



- RCS managed to capture only 13.8% of the graphics/plotting applications surveyed. This relatively low share can be explained by users' preferences for immediate visual verification of their graphics efforts. This immediate response is a user requirement that is unusually difficult for an RCS vendor to provide economically due mainly to geographical separation.

3. KEY APPLICATIONS

- Most of the applications for graphics/plotting, as previously stated, are integrated within other engineering/scientific applications packages. Of the standalone packages, however, DISSPLA from ISSCO was mentioned most frequently.

4. MARKET STRATEGY IMPLICATIONS

- RCS penetration of the graphics/plotting applications marketplace is relatively light. Because this is an area growing in use and importance, it is important that RCS vendors capture a larger share. The following are some suggestions:

  - Ensure that all of your engineering/scientific applications are offering graphics output.

  - Obtain more graphically oriented packages.

  - Distribute graphics output devices, such as Tektronics CRTs or HP plotters, as widely as possible. Concentrate on the engineering/scientific customer.

# V COMPETITIVE ANALYSIS

# V COMPETITIVE ANALYSIS

## A. RCS VENDOR SELECTION

- All survey respondents, both users and vendors, were asked a series of questions to ascertain which criteria are most important to them in selecting an RCS vendor.

- Respondents were asked to rate each reason for its importance in their firms. A ranking of 1 indicated irrelevance; a ranking of 5 indicated crucial importance. Exhibit V-1 contains a tabulation of user responses.

- Exhibit V-2 shows the average user responses to the questions, ordered from lowest to highest.

### 1. STUDY ANALYSIS

- The quality of an RCS vendor's support is the number one basis for selection. As Exhibit V-2 shows, not only did this reason gain the highest average score (4.10), it also elicited the most agreement from the user respondents. Vendors concurred: their average was 4.11. No users considered support irrelevant (see Exhibit V-1).

- Price/performance was rated by user respondents at an average of 4.03, a close second to support. Vendors rated it lower at 3.44. Although second in

EXHIBIT V-1

RCS VENDOR SELECTION CRITERIA

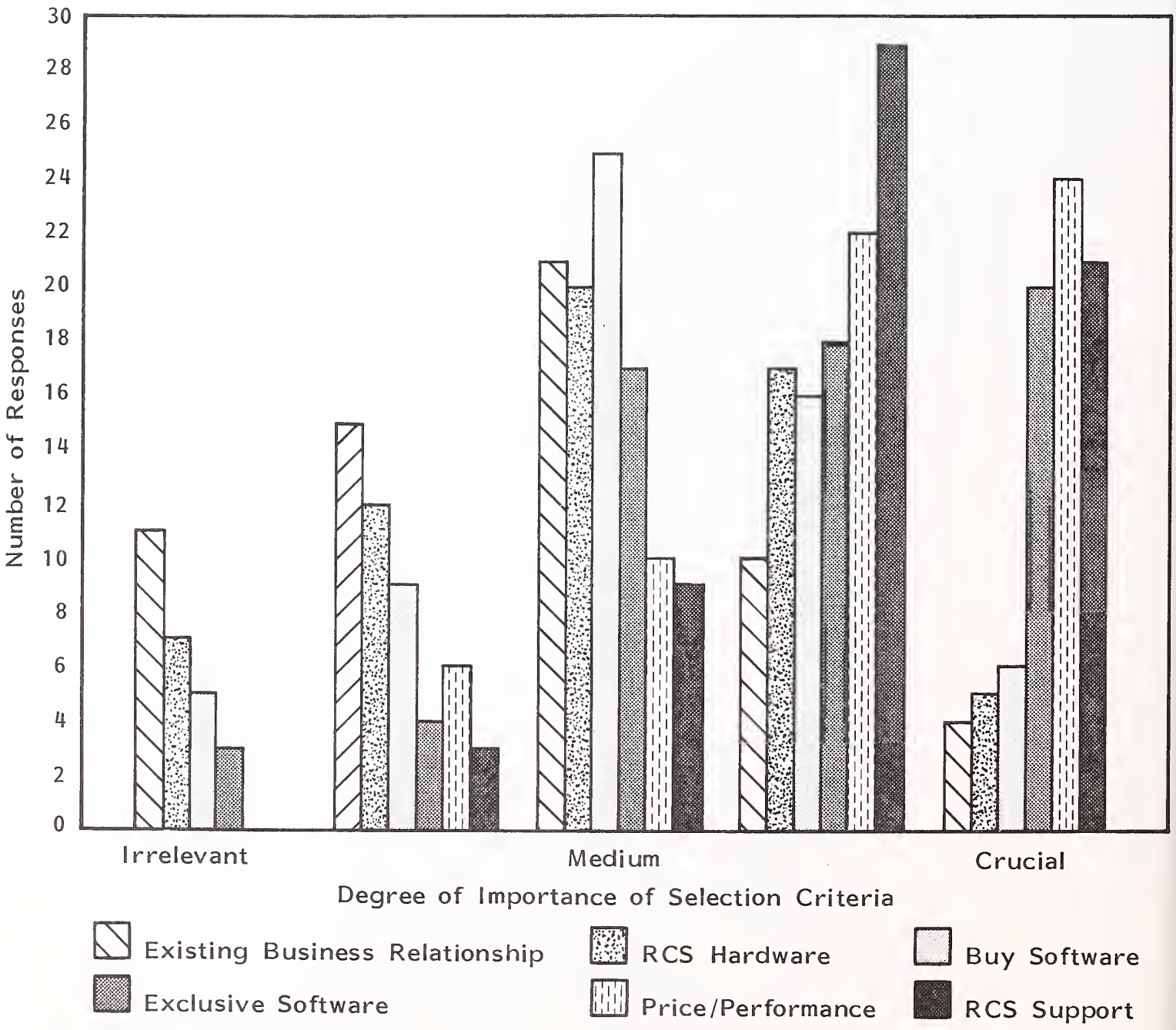
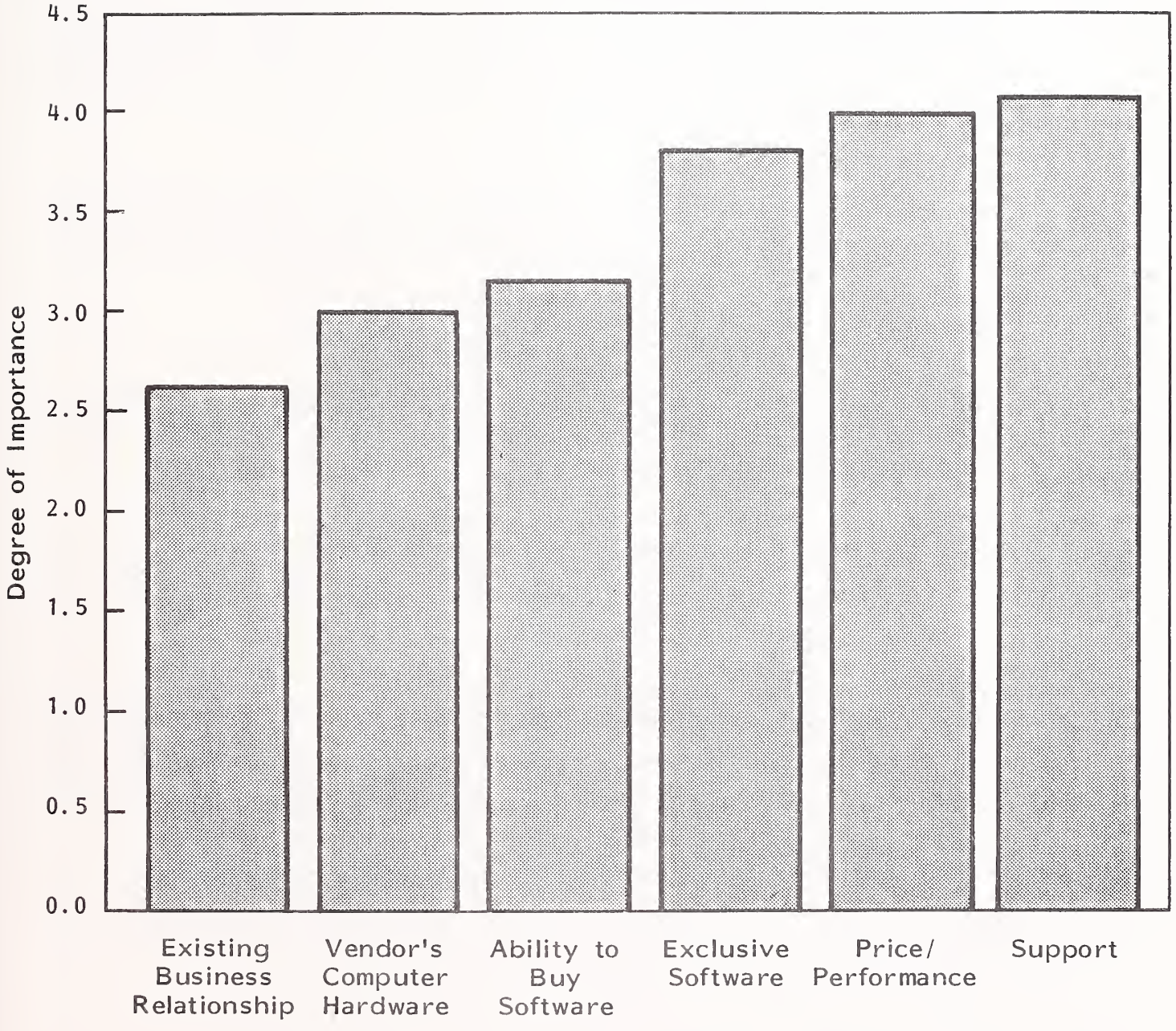


EXHIBIT V-2

REASONS TO CHOOSE AN RCS VENDOR



the ratings, more users rated price/performance as "crucial" than they did any other reason.

- The availability of an exclusive software offering was third with a score of 3.77. The vendor's average was 3.33.

- There is a substantial difference in the perceived importance of the first three reasons when compared with the remainder. The ability to buy the RCS software for in-house use received an average 3.15 rating. The vendor's hardware offering was rated at 2.97.

- The least important reason, from the users viewpoint, is an existing business relationship. The vendors, however, ranked this highest, with a score of 3.66.

2. RESULTS

- Support/cost squeeze: To be successful, an RCS vendor must provide application support at a reasonable cost.

  - Vendors are usually selected on the basis of applications support. This is especially true for the small- and medium-sized companies who need the high level of support.

  - In the past it was felt that, because computer costs were passed along to the engineering firm's client, cost was relatively unimportant. This is no longer true. Competition within the engineering community has made computer cost an issue.

- This is the same cost/support tightrope that many RCS vendors have been trying to walk for years.

- The RCS vendor's hardware complement is, for the most part, unimportant. This means that the majority of engineering/scientific RCS users no longer care if the CPU says IBM, CDC, or Cray.

- The engineering/scientific CPU marketplace has traditionally been dominated by CDC's Cyber line, with Cray a later entrant. These machines featured a very high computation speed and offered a long internal word width that offered increased computational accuracy.

- The later models of IBM CPUs, including the 303X, 434X, and newest 308X series, however, have gained engineering/scientific acceptance. Amdahl's computers are also accepted in the same way. This is primarily due to their increased speed when compared to older models.

- The increasing use of packaged engineering/scientific software is another reason for CPU indifference. The user concentrates on his application. The software vendor worries about file structures, word width, and cycle speed.

- Questioning the importance of an existing business relationship proved very illuminating.

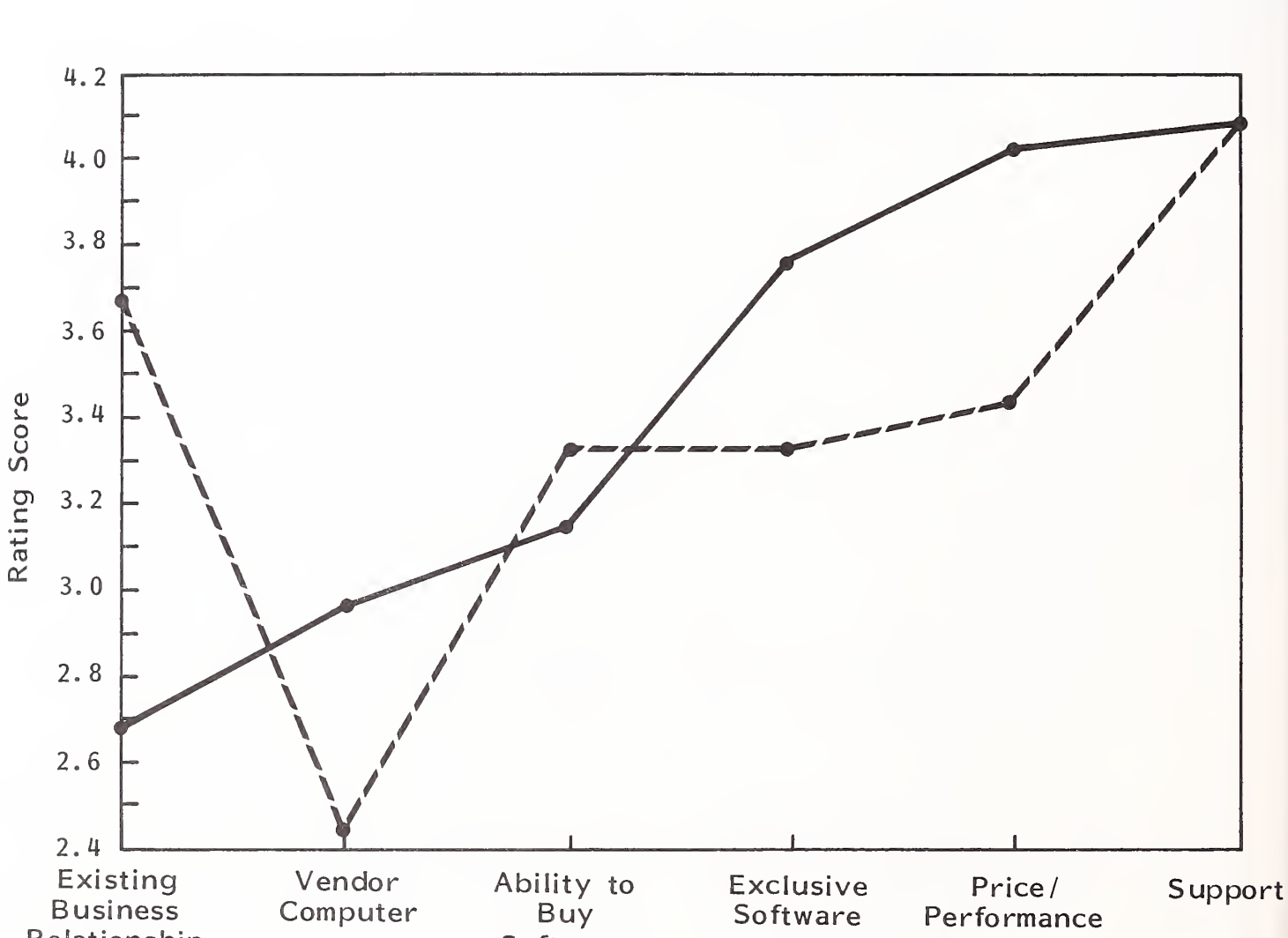
  - Users do not care if there is a vendor with an existing business relationship. More users rated it an "irrelevant" reason than they did any other.

  - Vendors, on the other hand, felt that an existing relationship was very important. As Exhibit V-3 illustrates, an existing business relationship was rated second.

  - Customers, therefore, have a low level of RCS vendor loyalty. But vendors think they have a better chance of winning a new contract if they are established and have good standing.

EXHIBIT V-3

CUSTOMER VERSUS VENDOR RATINGS OF
RCS VENDOR SELECTION CRITERIA



## 3. MARKETING STRATEGY IMPLICATIONS

- RCS vendors must develop strategies that simultaneously offer good price/performance and excellent support. A suggested strategy is outlined below:

  - Centralize applications expertise: Ensure that the major engineering/scientific applications are supported by one or more genuine experts in the application. These experts may be located at a branch or outlying office, but they must be available for telephone consultation. Branch offices must know whom to call for each application.

  - Offer regional training classes: Periodically offer regional, in-depth training classes in the most important applications. This will help develop the in-house expert who can proselytize for the application and vendor. Ensure that marketing representatives take advantage of this opportunity to have potential as well as current clients attend.

  - Deemphasize the importance of comprehensive local support: Recognize that a few real experts provide better support than many tyros.

- With this approach the RCS vendor can minimize the number of support personnel, can provide marketing reps with a reason to recontact potential customers, and can improve the level of support.

- The hardware race is over. RCS vendors are no longer forced to acquire the latest, fastest computer to be perceived as market leaders. CPUs can now be acquired for their price/performance alone, and not for their technological aura.

- Branch offices can now be equipped with IBM 4341s to offer local, interactive support for walk-in clients. This type of service improves the utility of many types of computing, especially graphics and plotting applications. Software support can be provided centrally.

- Centralized software and support with distributed and networked hardware recognize the cost trends in the industry. Because people and software are now the high-cost items, they must be centralized for efficient control and utilization. Hardware, on the other hand, is now a relatively low-cost item. It should now be distributed to users' locations as much as possible.

## B. PROFILE OF LEADING RCS VENDORS

- As with many other types of computer services, engineering/scientific RCS vendors are divided into a "two-tier" structure.

### 1. CHARACTERISTICS OF FIRST-TIER RCS VENDORS

- RCS vendors in the first tier are those that concentrate on the engineering/scientific marketplace, have a large library of programs available, offer a variety of support services, and derive a substantial revenue from their efforts. Firms in this category include Boeing Computer Services (BCS), Control Data Corporation's Cybernet, MCAUTO, University Computing Corporation (UCC), and the United Information Services (UIS) subsidiary of United Telecom Computer Group.

- The first-tier vendors provide a full range of services to their clients. Services offered include the following:

  - A broad program library: The first-tier vendors have extensive offerings in all of the major engineering/scientific disciplines. MCAUTO, for instance, at one time offered more than 500 engineering/scientific programs in its library. (This number has recently been trimmed, however, to weed out older, less used programs.) Each program made available "on the network" implies a commitment to keep it current

(with the latest release from the software vendor or author), to maintain literature and supporting marketing materials, and to have application-specific support available, should a user have technical questions.

- A variety of computing facilities: All of the first-tier vendors have many different models of computers. Most offer several different brands (IBM, CDC's Cyber, Univac, Cray, etc), and frequently they are dispersed into several widely separated data centers. (This last item depends upon the policy of the company and the expanse of their teleprocessing network.) Some engineers have become familiar with one brand of hardware and resist switching to another. Also, an application package may contain CPU-specific code. Both of these reasons are decreasing in importance, however.

- Applications support personnel: The engineering/scientific users surveyed considered the quality of the applications support the most important factor in choosing an RCS vendor (see section V-A, above). The first-tier vendors are aware of the importance of support. Each employs several graduate engineers at the corporate headquarters. In addition, branch offices are staffed with engineering support personnel. These support personnel are frequently specialists who are thoroughly familiar with several user applications and are available to support present clients or impress prospective clients with their ability. Indeed, differences in support quality between branches often leads one branch office to dominate a geographical area while another branch with weaker support personnel is routinely beaten out by the competition.

- Teleprocessing network: All of the first-tier vendors support or have access to a nationwide or worldwide telecommunications network. Such a network typically supports local dial-up access at speeds from 110 to 1,200 baud from most regions throughout the industrialized

world. Higher speed access, up to 56 kilobaud, is typically supported via in-WATS, leased line, or other means.

- In terms of noncaptive, calendarized revenues obtained in 1982, Exhibit V-4 details the size of the first-tier vendors in the engineering/scientific marketplace.

2. CONTROL DATA CORPORATION - CYBERNET

a. Overview

- Cybernet is the only one of the first-tier firms that exclusively serves the engineering/scientific marketplace. (Other elements of CDC Data Services provide business services.) It is also by far the largest. Cybernet had engineering/scientific revenues of $159 million in 1982.

- Cybernet offers an extremely broad selection of engineering/scientific applications programs.

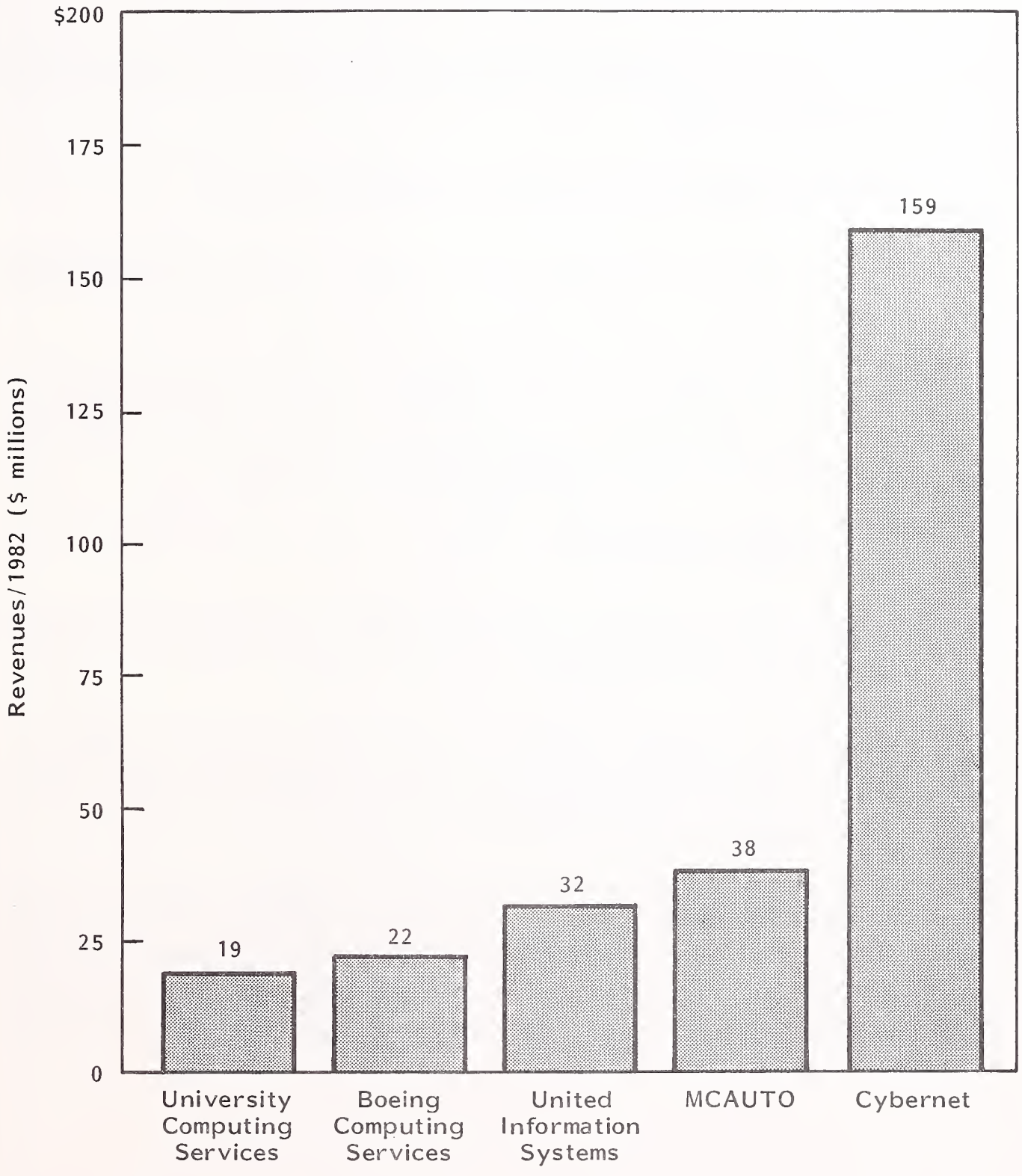
- In most disciplines, Cybernet offers professional services as well.

- Cybernet currently offers an integrated system (turnkey system) only for mining engineering. This offering, however, has not lived up to expectations and is being phased out.

- Cybernet acts as the marketing agent for many of the applications programs available on its network. Programs in structural, nuclear, project management, electrical, chemical, graphics, mining, and piping are available for sale through Cybernet.

EXHIBIT V-4

MAJOR ENGINEERING/SCIENTIFIC RCS VENDOR SIZES (1982 Revenue)



b. Major Strengths

- The major strength of Cybernet is its unique size and reputation. Most engineers have used Cybernet some time in their careers and can be confident that they will find software to help solve their problems.

- The extensive professional services offering enhances the utility of the processing services.

- Cybernet's largest application area is structural engineering.

- Cybernet also has a substantial business volume in project management applications.

- More than any other RCS vendor, Cybernet has enhanced and supported its offerings in the electrical and electronic engineering areas. Accordingly, Cybernet now dominates the RCS processing for this field.

c. Marketing Strategies

- Cybernet has the broadest and deepest offering of engineering software and professional services available.

- Cybernet, as a policy, does not offer proprietary software. Instead they acquire marketing rights to standard software and use their market size and skill to outperform the competition.

- Although the company does not yet have an extensive integrated systems offering, it is headed that way. Cybernet is developing integrated engineering software that will be packaged into integrated systems. These will then tie into the Cybernet network. These offerings will be more like an intelligent terminal than a complete standalone system.

## 3. MCDONNELL DOUGLAS AUTOMATION COMPANY

### a. Overview

- The McDonnell Automation Company was established as a separate division of the McDonnell Corporation in 1960 to support internal IS requirements and to sell excess time to the commercial sector. In 1968 the company began offering services. Emphasis on competing actively in the computer services market was reinforced in 1970 when the McDonnell and Douglas information facilities were merged to form the McDonnell Douglas Automation Company (MCAUTO).

- MCAUTO offers remote computing services, software products, professional services, and integrated systems to over 3,700 commercial clients throughout the U.S.

- In 1982 MCAUTO had engineering/scientific revenues of $38 million. This includes $15 million in project management revenues that are normally reported separately from their engineering/scientific revenues.

- MCAUTO has been one of the leaders of the RCS community, averaging more than 20% growth over the last seven years.

- MCAUTO has built itself up in the engineering/scientific marketplace on two cornerstones: proprietary software and support.

- Alone, among all the major RCS vendors, MCAUTO has insisted upon building up its own set of applications software. MCAUTO STRUDL, derived from the public domain program, represents many millions of dollars in proprietary enhancements. Each of MCAUTO's major engineering/scientific offerings was either acquired exclusively or was developed internally.

- MCAUTO has complemented this proprietary software with excellent support. In the survey conducted for this study, MCAUTO received more high marks for its engineering/scientific support than did any other vendor.

b. Marketing Strategy

- MCAUTO plans to grow explosively in the engineering/scientific marketplace in the next five years.

- MCAUTO expects to slow its growth in RCS 10% to 15% per year.

- The professional services business is offered only as an accommodation to its customers. Although MCAUTO has professional services offerings in many of the important disciplines, development of new business is not being encouraged.

- MCAUTO has announced an integrated system called the MACAUTO System 1. Based upon Digital Equipment Corporation VAX computers, this integrated system is being offered with a complete set of MCAUTO proprietary software:

  - It supports the ICES Executive System.

  - Programs are available from the STRUDL group:

    . DESIGN GROUP.
    . RECON.
    . TOWER.
    . DYNAL.
    . NON-LINEAR.
    . DANOS.
    . DATABASE.
    . SELOS.

- Also available are other programs and data communications utilities:

  - HASP Plus.
  - Pipeline.
  - COGO.
  - ROADS.
  - SLOPE.
  - FASTDRAW.
  - FIESTA.

- Users may also purchase interfaces with the UNIGRAPHICS CAD/CAM system and the BDS/GDS graphics design systems.

- MCAUTO is offering the System I on very flexible terms:

  - Purchase.

  - Rental/lease.

  - Pay-as-you-go usage charges.

- Users may operate their System I on either standalone or by hooking into the regular MCAUTO network.

- Revenue for this new introduction is expected to grow rapidly to more than $100 million within five years.

- MCAUTO also expects to expand its software sales dramatically. Software sales revenues were $2 million in 1982 and are expected to grow 100% per year for the next few years.

## 4. UNITED TELECOM COMPUTER GROUP - UNITED INFORMATION SERVICES, INC.

### a. Overview

- United Information Services, Inc. (UIS) provides remote computing services to over 2,000 companies in a variety of industries. Revenues for engineering/scientific information services were $30 million in calendar 1982.

- The principal UIS product is APEX, the timesharing operating environment of UIS's computer network. Through APEX, UIS offers access to CDC Cybers and a Cray computer in over 200 cities in the U.S., Canada, and Europe.

- UIS derives all of its engineering/scientific revenue from processing services. UIS has no offerings in professional services, integrated systems, or software sales.

- UIS has had a difficult time recently. Revenues for 1982 were off 9% from the previous year, and the company showed a very small profit in the calendar year.

### b. Major Strengths

- UIS has long specialized in serving the engineering/scientific marketplace. It was the first commercial user of the Cray computer.

- While providing the requisite support, UIS has been especially vigorous in pricing its offerings. Batch processing costs on the Cray can be particularly attractive to users.

- UIS is strong in structural engineering, which accounted for $16 million in 1982.

- Other significant engineering disciplines include chemical/process engineering, piping, and energy exploration.

c. Marketing Strategy

- UIS has recognized that the impact of in-house computing from the IS data center, as well as from mini and personal computers will increase.

- UIS plans to offer a packaged communications facility to its customers to help them control costs.

  - This system, as yet unnamed, consists of a circuit board that is inserted in the customer's computer, a modem, a high-speed (9,600 baud) leased line, and necessary software.

  - The customer can use his minicomputer (typically a DEC VAX model) to perform front-end setup and analysis.

  - All data can then be shipped over the high-speed telecommunications lines to the UIS data center for "crunching." The results and any modified data are transmitted back to the customer.

  - The customer will pay only for processing charges and a monthly fee for the communications facility. No storage or other charges will be incurred because no data is resident at UIS.

- UIS also plans to introduce integrated systems in support of structural engineering, PC board layout, and piping analysis.

- UIS is actively encouraging development of new software with its "authors" program, whereby UIS assumes the responsibility for packaging, documenting, and marketing newly developed applications software.

## 5. BOEING COMPUTER SERVICES

### a. Overview

- Boeing Computer Services (BCS) was formed as a wholly owned subsidiary of the Boeing Company in 1970. In 1978 BCS became a division of Boeing.
- BCS noncaptive information services are estimated to be $94 million in 1983. The engineering/scientific revenues were $23 million, a 24% share of the total.
- In addition to processing services, BCS also offers software for sale and has a large professional services offering.

### b. Major Strengths

- BCS's major strength lies in its ability to offer a full line of services to the engineering/scientific community.
- BCS has developed one of the largest privately managed communications networks. It serves the U.S., Canada, and the United Kingdom.
- BCS offers engineering/scientific computing on an array of IBM and CDC computers.
- BCS is very price competitive.

### c. Marketing Strategy

- BCS presents a well-rounded, mainstream offering to its clients.
- Their network supports a standard set of engineering/scientific software that includes structural, piping, civil, nuclear, and mechanical engineering.

- BCS is especially vigorous in supporting project management software, particularly Project/2 from PSDI.

6. UNIVERSITY COMPUTING COMPANY

a. Overview

- The University Computing Company (UCC) is a wholly owned subsidiary of the Wyly Corporation. Wyly Corporation was formed in 1963 in Dallas, Texas.

- Perhaps best known for its data processing systems and applications software products, UCC also offers a limited amount of engineering/scientific software.

- UCC provides an array of engineering/scientific information services but does not offer professional services as a complement.

- While the company has an active integrated systems offering in numerical control packages, there is as yet no engineering/scientific integrated systems offering.

- Information services revenues for engineering/scientific computing were $19 million in 1982.

b. Major Strengths

- Because it is smaller than some of the other major engineering/scientific RCS vendors, UCC has used its flexibility and competitiveness to build business in specific areas.

- UCC is the dominant provider of information services to the electric power industry. They have an unmatched array of products and services for this industry and have captured most of the market.

- As a part of the services to the electric power industry, UCC has an active quality assurance program for its engineering/scientific programs. Before programs are released for general use, their correct operation is verified and documented by one of several experts on the UCC staff.

- As the smallest of the major engineering/scientific RCS vendors, UCC has been very competitive and price conscious.

c. Marketing Strategy

- UCC has been very successful in targeting its services in the past and will continue to be so in the future while making required adjustments for market shifts.

- UCC will begin to offer its portfolio of electric power packages on an integrated system in the near future.

- UCC has also identified the engineering/scientific data base market as an area for growth and is marketing its DB4 software product. In order to promote this area, UCC also plans to offer professional services.

## C. LEADING SOFTWARE VENDORS

- In the course of conducting the survey for this study, INPUT tallied several hundred user responses concerning their applications software experiences. The two companies that were consistently mentioned as having outstanding products are briefly profiled here.

## 1. PROJECT SOFTWARE AND DEVELOPMENT, INCORPORATED

- Project Software and Development Incorporated (PSDI) provides services to individuals and firms needing project management assistance.

- PSDI is headquartered in Cambridge, Massachusetts, but has 170 employees spread out over 10 branch offices. INPUT estimates that PSDI's revenues in 1982 were $14 million. Offerings include professional services, integrated systems, and software rental/lease.

- The mainstay of PSDI's offerings is a project management software product, Project/2. This package was derived from the MIT ICES Project/1 package.

- Project/2 is the major project management software package on the market today and is available as a service from a wide number of RCS vendors. Most of PSDI's revenues come from royalty revenues paid by these RCS vendors.

- PSDI has used RCS vendors as its marketing vehicle. Each RCS customer using Project/2 is registered with PSDI and is eligible to receive PSDI support. More than one-half of PSDI's personnel are involved in support. PSDI has historically been reluctant to allow non-RCS firms to run the Project/2 software.

- In recent years PSDI has begun to make Project/2 available for in-house use in IS data centers. As a policy, PSDI never sells the Project/2 software but may lease or rent it.

- PSDI has recently acquired rights to the relational data base Oracle and has begun to adapt it to the Project/2 system.

- PSDI has also begun to offer integrated systems. Currently available is the Project/2 Machine, a DEC VAX 11/730 packaged with Project/2 network, costing, graphics, and data base software. The price is $6,500 per month.

## 2. MACNEAL-SCHWENDLER CORPORATION

- The MacNeal-Schwendler Corporation (MSC) specializes in providing structural engineering software and services. MSC's revenue for 1982 was $7.2 million.

- MSC has adapted and greatly enhanced NASA's NASTRAN structural engineering software. It provides a comprehensive capability for static and dynamic analysis as well as heat transfer, acoustics, and electromagnetics. MSC/NASTRAN is the industry's standard structural engineering package and is available from more RCS vendors than any other package.

- MSC/NASTRAN has been available for many years from major RCS vendors running on CDC, IBM, UNIVAC, and Cray computers. Recently, however, MSC has modified the package to run on Digital's VAX and the Apollo Computer series of engineering workstations.

# VI CONCLUSIONS AND RECOMMENDATIONS

# VI CONCLUSIONS AND RECOMMENDATIONS

## A. MAJOR MARKETPLACE CHANGES

### 1. PROCESSING SERVICES

- INPUT projects relatively slow growth for the total engineering/scientific RCS marketplace.

- There will be stagnation or shrinkage of some engineering/scientific RCS markets, particularly nuclear engineering.

### 2. PROFESSIONAL SERVICES

- Professional services will continue to be offered, but will not develop into a major market. Most information services firms offer professional services as an accommodation to existing clients. The offering is expected to bring in new RCS business or to hold existing business but not to generate substantial revenue.

### 3. INTEGRATED SYSTEMS

- Integrated systems will be a fast-growing engineering/scientific market for the next five years.

- Excluding CAD/CAM, total revenue for engineering/scientific integrated systems was a miniscule $34 million in 1982. This is expected to grow to $500 million in 1988, an AAGR of 56.5%.

4. SOFTWARE SALES

- Software sales will grow rapidly as firms buy engineering/scientific software for their existing in-house computer systems.

- Applications now only found on mainframe computers will be offered for smaller CPUs.

## B. COMPETITIVE ACTIVITY AND TRENDS

1. PROCESSING SERVICES

- User site hardware services (USHS) will become a factor in the processing services market for the first time. Several of the major engineering/scientific RCS vendors have already introduced, or will shortly introduce, USHS offerings.

- Engineering data bases will be offered and will increasingly gain use.

- UCC, as part of its support of the electric power industry, has been supporting a software certification program. This competitive advantage will become more and more important as governmental agencies increasingly require that engineering software undergo a certification process.

2. INTEGRATED SYSTEMS

- Almost every major RCS and software vendor is bringing forth unique integrated systems offerings, most of which appear to be based upon Digital Equipment Corporation's VAX series.

3. SOFTWARE SALES

- Sales of engineering/scientific software is just beginning to emerge from the shadow of RCS.

- Major "brand name" software such as MSC NASTRAN, Swanson Analysis Systems' ANSYS, and even MCAUTO STRUDL is being offered to in-house engineering/scientific users on a variety of CPUs.

- Engineering software firms that formerly were utilizing a passive, technical selling approach are becoming aggressive.

## C. RECOMMENDATIONS

- The next few years will be very difficult ones for companies in the engineering/scientific processing services business. Competitive pressures will come not only from direct competitors but also from software vendors and mini and personal computer manufacturers. Companies that can devise and implement creative strategies will survive and prosper. Those that rely on tried and true approaches will see their revenues stagnate or decline. Although the unique position of each firm will dictate the actual strategy implemented, INPUT offers the following general guidelines.

- Concentrate support: Effective engineering/scientific support personnel are very expensive. Yet just such personnel are necessary to remain competitive

in the engineering/scientific marketplace. Vendors may reduce costs and increase perceived service by centralizing their support personnel. See Chapter V, section A3, for a complete discussion.

- Distribute hardware: Formerly expensive hardware is now inexpensive enough to be placed in branch offices and/or customer locations. Minicomputers such as the VAX 11/730 can be rented to customers based on use. Smaller mainframes such as the IBM 4341 can be placed in branch offices to provide superior interactive access. In both cases the vendor can provide software and software support from a central office.

- Broaden computing mode support: A major strategy for RCS vendors will be to support computing mode integration within their engineering/scientific offering. A proprietary offering that supports personal or minicomputers acting as front- and back-end processors, coupled with an easy-to-use telecommunications access and mainframe software will be very successful. Although the proprietary aspect may lie in the manner in which the various components are packaged, the most sucessful strategy will be to offer the maximum amount of proprietary content. Some possiblities:

  - Telecommunications: A proprietary telecommunications link will make the use of a given RCS vendor easier and therefore more effective.

  - User site hardware: An RCS vendor can profitably offer a complete processing solution on the user's site. MCAUTO has recognized this opportunity and is currently offering its customers their MCAUTO System 1. This turnkey package is available to MCAUTO customers either for purchase, lease/rent, or based on use. In addition to just the computer, MCAUTO is offering their proprietary engineering/ scientific software, including the popular MCAUTO STRUDL. This offering can be used with the other MCAUTO offerings or as a standalone computer.

- User site software: Proprietary software given or rented to a customer - software that connects only with the RCS vendor's software - will be very effective in attracting and retaining engineering customers.

- Offer alternate delivery modes: Diversify away from dependence strictly on processing services by offering more modes of delivery - professional services, integrated systems, software sales. The latter two modes promise the highest rates of growth in this marketplace in the next five years.

- Utilize marketing/sales strengths: Use in-house marketing experience to acquire exclusive or regional distribution rights to in-demand engineering/scientific software products. Apply technical strengths to attractive packaging of the acquired products. Train the existing marketing and sales staff to sell alternate modes of delivery.

# APPENDIX A: USER QUESTIONNAIRE

CONFIDENTIAL

INPUT QUESTIONNAIRE
April 7, 1983

STUDY TITLE: Opportunities for Eng/Sci Computer Services.

Type of Interview: ( X ) User

CATALOG NO: M E S 3 __.__.__. (1)
S I C CODE: __.__.__.__.__. (2)
SIZE CODE: __.__. (3)
AREA CODE: __.__.__. (4)
STUDY CODE: __.__. (5)
DATES: __.__.__.__.__.__. (6)
M M D D Y Y

---

Input Interviewer: _____ (7) Date: _____ (8)

Respondent: _____ (9)

Title: _____ (10)

Company: _____ (11)

Address 1: _____ (12)

Address 2: _____ (13)

City, State Zip: _____ (14)

Phone num: _____ (15)

Company Size: Sales per annum:(16)
Num of Employees:(17)

Industry:(18)

( ) Discrete Mfg
( ) Process Mfg
( ) Architects & Eng
( ) Utilities
( ) Contsruction
( ) Eng Consultants
( ) Federal Govt.
( ) State, Local Govt.
( ) Research Firm
( ) University
( ) Other _____ (19)

Comments: _____

1. Do you select or recommend your firm's Remote Computing Service Vendors for Engineering/Scientific computing? (If "no" then inquire who does that task, get his/her name and number and call that individual. Terminate this interview with a "Thank You.")(20)

2. Are there any other individuals involved in the decision-making process? What are their positions or job functions? (We do not want names, just job titles.)(21)

3. To what extent does your firm's Information Services department become involved with your selection of an outside Remote Computer Services vendor for Eng/Sci work? Please use a scale of 1 to 5, where 1 is very little or no involvement, and 5 is very involved. _____(22)

4. What is your job title or function?(23)

5. What is your department?(24)

6. How many professionals (Engineers or Scientists) are in your firm? _____(25)

7. Could you list 2 or 3 important ways that the engineer's or scientist's job has changed in the past 5 years? Why?(26)

8. In what important ways do you see their jobs changing in the next 5 years? Why?(27)

9. Would you briefly describe what computers and computer services you use to support your engineering/scientific work?

Sci/Eng Software Packages:(28) _____

Single-user or Personal Computers ($<15,000):(29) _____

Multi-user or MiniComputer (15,000 < $ <300,000):(30) _____

Corporate Data Center (Information Services):(31) _____

Outside Remote Computer Service (RCS) Vendor:(32) _____

Other Computers or computer services:(33) _____

10. Would you please tell me, in round numbers, what your firm has budgeted this year for computers or computing to support the Eng/Sci area? $_____ (34)

11. Please tell us how your firm allocated this budget among the above types of computers and computer services in support of your firm's engineering and scientific work. Also tell me how you see the spending changing in the future.

| Category | Spent in Past Year $ | Change in Past Year | Spending during Next 3 Years |
|---|---|---|---|
| Total Spending | $_____ (36) | ____% (43) | $_____ (50) |
| Sci/Eng Software Packages | $_____ (37) | ____% (44) | $_____ (51) |
| Single-user or Personal Computers ($<15,000) | $_____ (38) | ____% (45) | $_____ (52) |
| Multi-user or MiniComputer (15,000 < $ <300,000) | $_____ (39) | ____% (46) | $_____ (53) |
| Corporate Data Center (Information Services) | $_____ (40) | ____% (47) | $_____ (54) |
| Outside Remote Computer Service (RCS) Vendor | $_____ (41) | ____% (48) | $_____ (55) |
| Other_____ (35) | $_____ (42) | ____% (49) | $_____ (56) |

12. What are some of the important reasons for your change in spending among the alternatives? (57)

_____

_____

13. In choosing what computing resource to use among those that I have already mentioned (single-user, multi-user, IS data center, or Remote Computer Services Vendor), how would you rate the following factors (1 is least important, 5 is most critical)?

| Factor | Rating |
|---|---|
| a. Packaged Software availability | ____ (58) |
| b. Software Integrated with other applications | ____ (59) |
| c. Absolute Lowest Cost | ____ (60) |
| d. Best Price/Performance | ____ (61) |
| e. Speed of CPU | ____ (62) |
| f. Intrinsic Accuracy of CPU (internal word width) | ____ (63) |
| g. Application support available by Telephone | ____ (64) |
| h. Application support available locally | ____ (65) |

i. Existing In-house expertise on application _____ (66)

j. Availability of quick turnaround _____ (67)

k. Ease of Software use _____ (68)

l. Availability of pre-existing facility or bus. relationship (i. e. Existing computer, Open PO, ongoing contract, etc.) _____ (69)

m. Are there any other very important considerations that you would like to mention? (70)

_____

_____

14. I am going to list several reasons to choose among Remote Computer Services vendors. Please rate these reasons. (1 means not important at all; 5 is critical importance.)

(71)a._____ Existing business relationship (Open PO, vendor is on GSA schedule, etc.)

(72)b._____ Relative quality of support and/or training provided by Remote Computer Services Vendor.

(73)c._____ Price/performance of Remote Computer Services Vendor.

(74)d._____ Availability of proprietary software (not available elsewhere).

(75)e._____ Need for particular set of hardware facilities ( i. e. CPU brand, plotter, peripherals, teleprocessing network, etc.)

(76)f._____ Ability to purchase RCS applications software for subsequent in-house use.

15. If you need a specific set of hardware, what is it?

(77)a._____ Specific CPU Brand. What is it?_____ (78)

(79)b._____ Plotter available.

(80)c._____ Other Peripheral. What is it?_____ (81)

(82)d._____ teleprocessing network needed. What kind is required?_____ (83)

(84)e._____ Other _____ (85)

16. What are your favorite Remote Computer Services vendors for Eng/Sci? (Limit of three) Why?

_____

_____ (86)

17. Are there any Remote Computer Services vendors that you are dissatisfied with? Who are they? Why? (87)

_____

_____

18. We are interested in a detailed examination of several Eng/Sci disciplines. As I list them, please tell me whether your firm does work in this area.

| Check | Discipline | Followup questions |
|---|---|---|
| _____ (88) | Structural | Question 19 |
| _____ (89) | Project Managment | Question 20 |
| _____ (90) | Civil | Question 21 |
| _____ (91) | Nuclear | Question 22 |
| _____ (92) | Graphics(not CAD/CAM) | Question 23 |

Is there a discipline, not listed above, that accounts for a significant portion of your work?

_____ (93) Other_____ (94) Question 24

19. STRUCTURAL ENGINEERING

a. What percent of your firm's spending for computers or computer services is in support of structural engineering? _____% (95)

b. How has your firm's workload in structural engineering changed in the past year? _____% (96)

c. How has that affected your sepending on computers or computer services? _____% (97)

d. How do you expect your workload in structural engineering change in the next 12 to 18 months? _____% (98)

e. How will that effect your spending on computers or computer services? _____% (99)

f. What is(are) the reason(s) for the change(s)? (100)

_____

_____

g. Would you name the several of the more important computer applications in your firm's structural engineering work:

Application

_____ (101)
(102) ___ Internally Developed
(103) ___ Public Domain Software Source: _____ (104)
(105) ___ Commercial Software Package

Used on:
(106) ___ Pers Computer
(107) ___ Mini Computer
(108) ___ IS Data Center
(109) ___ RCS Service
(Name: _____) (110)
(Mo Spending: $_____) (111)

Vendor: _____ (112)
Package Name: _____ (113)
Price: $_____ (114) (only if purchased)

_____ (115)
(116) ___ Internally Developed
(117) ___ Public Domain Software Source: _____ (118)
(119) ___ Commercial Software Package

Used on:
(120) ___ Pers Computer
(121) ___ Mini Computer
(122) ___ IS Data Center
(123) ___ RCS Service
(Name: _____) (124)
(Mo Spending: $_____) (125)

Vendor: _____ (126)
Package Name: _____ (127)
Price: $_____ (128) (only if purchased)

_____(129) (130)___ Internally Developed
(131)___ Public Domain Software Source:_____(132)
(133)___ Commercial Software Package

Used on:

(134)___ Pers Computer
(135)___ Mini Computer
(136)___ IS Data Center
(137)___ RCS Service
(Name:_____)(138)
(Mo Spending:$_____)(139)

Vendor:_____(140)
Package Name:_____(141)
Price:$_____(142) (only if purchased)

h. Are there any important new structural engineering applications that you have added in the past year?

(1)_____(143)

(2)_____(144)

(3)_____(145)

i. Are there any important new applications that you plan on adding in the next year?

Application

_____(146) (147)___ Internally Developed
(148)___ Public Domain Software Source:_____(149)
(150)___ Commercial Software Package

Used on:

(151)___ Pers Computer
(152)___ Mini Computer
(153)___ IS Data Center
(154)___ RCS Service
(Name:_____)(155)
(Mo Spending:$_____)(156)

Vendor:_____(157)
Package Name:_____(158)
Price:$_____(159) (only if purchased)

(160)_____ (161)___ Internally Developed
(162)___ Public Domain Software Source:_____(163)
(164)___ Commercial Software Package

Used on:

(165)___ Pers Computer
(166)___ Mini Computer
(167)___ IS Data Center
(168)___ RCS Service
(Name:_____)(169)
(Mo Spending:$_____)(170)

Vendor:_____(171)
Package Name:_____(172)
Price:$_____(173) (only if purchased)

j. Please tell us what computers or computer services your firm purchased in the past year to support your structural engineering. Also tell us how you see this purchasing pattern changing in the future.

| Category | $ Spent | Change fm Prior Yr | Change in Next 3 Yrs |
|---|---|---|---|
| Total Spending | $_____ (175) | _____% (182) | _____% (199) |
| Sci/Eng Software Packages | $_____ (176) | _____% (183) | _____% (190) |
| Single-user or Personal Computers ($<15,000) | $_____ (177) | _____% (184) | _____% (191) |
| Dept-owned Multi-user (15,000 < $ <300,000) | $_____ (178) | _____% (185) | _____% (192) |
| Corporate Data Center (IS machine) | $_____ (179) | _____% (186) | _____% (193) |
| Outside Remote Computer Service (RCS) Vendor | $_____ (180) | _____% (187) | _____% (194) |
| Other_____ (174) | $_____ (181) | _____% (188) | _____% (195) |

k. What are some of the important reasons for your changing usage? (196)

_____

_____

20. CIVIL ENGINEERING

a. What percent of your firm's spending for computers or computer services is in support of civil engineering? _____%(197)

b. How has your firm's workload in civil engineering changed in the past year? _____%(198)

c. How has that affected your sepending on computers or computer services? _____%(199)

d. How do you expect your workload in civil engineering change in the next 12 to 18 months? _____%(200)

e. How will that effect your spending on computers or computer services? _____%(201)

f. What is(are) the reason(s) for the change(s)?(202)

_____

_____

g. Would you name the several of the more important computer applications in your firm's civil engineering work:

Application

_____(203)

(204)___Internally Developed
(205)___Public Domain Software Source:_____(206)
(207)___Commercial Software Package

Used on:
(208)___Pers Computer
(209)___Mini Computer
(210)___IS Data Center
(211)___RCS Service
(Name:_____)(212)
(Mo Spending:$_____)(213)

Vendor:_____(214)
Package Name:_____(215)
Price:$_____(216)(only if purchased)

_____(217)

(218)___Internally Developed
(219)___Public Domain Software Source:_____(220)
(221)___Commercial Software Package

Used on:
(222)___Pers Computer
(223)___Mini Computer
(224)___IS Data Center
(225)___RCS Service
(Name:_____)(226)
(Mo Spending:$_____)(227)

Vendor:_____(228)
Package Name:_____(229)
Price:$_____(230)(only if purchased)

_____(231) (232)___Internally Developed
(233)___Public Domain Software Source:_____(234)
(235)___Commercial Software Package

Used on:
(236)___Pers Computer
(237)___Mini Computer
(238)___IS Data Center
(239)___RCS Service
(Name:_____)(240)
(Mo Spending:$_____)(241)

Vendor:_____(242)
Package Name:_____(243)
Price:$_____(244)(only if purchased)

h. Are there any important new civil engineering applications that you have added in the past year?

(1)_____(245)

(2)_____(246)

(3)_____(247)

i. Are there any important new applications that you plan on adding in the next year?

Application

(248)_____(249)___Internally Developed
(250)___Public Domain Software Source:_____(251)
(252)___Commercial Software Package

Used on:
(253)___Pers Computer
(254)___Mini Computer
(255)___IS Data Center
(256)___RCS Service
(Name:_____)(257)
(Mo Spending:$_____)(258)

Vendor:_____(259)
Package Name:_____(260)
Price:$_____(261)(only if purchased)

_____(262) (263)___Internally Developed
(264)___Public Domain Software Source:_____(265)
(266)___Commercial Software Package

Used on:
(267)___Pers Computer
(268)___Mini Computer
(269)___IS Data Center
(270)___RCS Service
(Name:_____)(271)
(Mo Spending:$_____)(272)

Vendor:_____(273)
Package Name:_____(274)
Price:$_____(275)(only if purchased)

j. Please tell us what computers or computer services your firm purchased in the past year to support your civil engineering. Also tell us how you see this purchasing pattern changing in the future.

| Category | $ Spent | Change fm Prior Yr | Change in Next 3 Yrs |
|---|---|---|---|
| Total Spending | $_____ (277) | _____% (284) | _____% (291) |
| Sci/Eng Software Packages | $_____ (278) | _____% (285) | _____% (292) |
| Single-user or Personal Computers ($<15,000) | $_____ (279) | _____% (286) | _____% (293) |
| Dept-owned Multi-user (15,000 < $ <300,000) | $_____ (280) | _____% (287) | _____% (294) |
| Corporate Data Center (IS machine) | $_____ (281) | _____% (288) | _____% (295) |
| Outside Remote Computer Service (RCS) Vendor | $_____ (282) | _____% (289) | _____% (296) |
| Other_____ (276) | $_____ (283) | _____% (290) | _____% (297) |

k. What are some of the important reasons for your changing usage? (298)

_____

_____

21. NUCLEAR ENGINEERING

a. What percent of your firm's spending for computers or computer services is in support of nuclear engineering? _____%(299)

b. How has your firm's workload in nuclear engineering changed in the past year? _____%(300)

c. How has that affected your sepending on computers or computer services? _____%(301)

d. How do you expect your workload in nuclear engineering change in the next 12 to 18 months? _____%(302)

e. How will that effect your spending on computers or computer services? _____%(303)

f. What is(are) the reason(s) for the change(s)?(304)

_____

_____

g. Would you name the several of the more important computer applications in your firm's nuclear engineering work:

Application

(305)_____ (306)___Internally Developed
(307)___Public Domain Software Source:_____ (308)
(309)___Commercial Software Package

Used on:
(310)___Pers Computer
(311)___Mini Computer
(312)___IS Data Center
(313)___RCS Service
(Name:_____)(314)
(Mo Spending:$_____)(315)

Vendor:_____ (316)
Package Name:_____ (317)
Price:$_____ (318) (only if purchased)

_____ (319) (320)___Internally Developed
(321)___Public Domain Software Source:_____ (322)
(323)___Commercial Software Package

Used on:
(324)___Pers Computer
(325)___Mini Computer
(326)___IS Data Center
(327)___RCS Service
(Name:_____)(328)
(Mo Spending:$_____)(329)

Vendor:_____ (330)
Package Name:_____ (331)
Price:$_____ (332) (only if purchased)

_____(333) (334)___Internally Developed
(335)___Public Domain Software Source:_____(336)
(337)___Commercial Software Package

Used on:
(338)___Pers Computer
(339)___Mini Computer
(340)___IS Data Center
(341)___RCS Service
(Name:_____)(342)
(Mo Spending:$_____)(343)

Vendor:_____(344)
Package Name:_____(345)
Price:$_____(346)(only if purchased)

h. Are there any important new nuclear engineering applications that you have added in the past year?

(1)_____(347)

(2)_____(348)

(3)_____(349)

i. Are there any important new applications that you plan on adding in the next year?

Application
(350)_____

(351)___Internally Developed
(352)___Public Domain Software Source:_____(353)
(354)___Commercial Software Package

Used on:
(355)___Pers Computer
(356)___Mini Computer
(357)___IS Data Center
(358)___RCS Service
(Name:_____)(359)
(Mo Spending:$_____)(360)

Vendor:_____(361)
Package Name:_____(362)
Price:$_____(363)(only if purchased)

_____(364)

(365)___Internally Developed
(366)___Public Domain Software Source:_____(367)
(368)___Commercial Software Package

Used on:
(369)___Pers Computer
(370)___Mini Computer
(371)___IS Data Center
(372)___RCS Service
(Name:_____)(373)
(Mo Spending:$_____)(374)

Vendor:_____(375)
Package Name:_____(376)
Price:$_____(377)(only if purchased)

j. Please tell us what computers or computer services your firm purchased in the past year to support your nuclear engineering. Also tell us how you see this purchasing pattern changing in the future.

| Category | $ Spent | Change fm Prior Yr | Change in Next 3 Yrs |
|---|---|---|---|
| Total Spending | $_____ (379) | _____% (386) | _____% (393) |
| Sci/Eng Software Packages | $_____ (380) | _____% (387) | _____% (394) |
| Single-user or Personal Computers ($<15,000) | $_____ (381) | _____% (388) | _____% (395) |
| Dept-owned Multi-user (15,000 < $ <300,000) | $_____ (382) | _____% (389) | _____% (396) |
| Corporate Data Center (IS machine) | $_____ (383) | _____% (390) | _____% (397) |
| Outside Remote Computer Service (RCS) Vendor | $_____ (384) | _____% (391) | _____% (398) |
| Other_____ (378) | $_____ (385) | _____% (392) | _____% (399) |

k. What are some of the important reasons for your changing usage? (400)

_____

_____

22. PROJECT MANAGEMENT

a. What percent of your firm's spending for computers or computer services is in support of project management? _____% (401)

b. How has your firm's workload in project management changed in the past year? _____% (402)

c. How has that affected your sepending on computers or computer services? _____% (403)

d. How do you expect your workload in project management change in the next 12 to 18 months? _____% (404)

e. How will that effect your spending on computers or computer services? _____% (405)

f. What is(are) the reason(s) for the change(s)? (406)

_____

_____

g. Would you name the several of the more important computer applications in your firm's project management work:

Application

_____ (407)

(408) ___ Internally Developed
(409) ___ Public Domain Software Source: _____ (410)
(411) ___ Commercial Software Package

Used on:
(412) ___ Pers Computer
(413) ___ Mini Computer
(414) ___ IS Data Center
(415) ___ RCS Service
(Name: _____ ) (416)
(Mo Spending: $_____ ) (417)

Vendor: _____ (418)
Package Name: _____ (419)
Price: $_____ (420) (only if purchased)

_____ (421)

(422) ___ Internally Developed
(423) ___ Public Domain Software Source: _____ (424)
(425) ___ Commercial Software Package

Used on:
(426) ___ Pers Computer
(427) ___ Mini Computer
(428) ___ IS Data Center
(429) ___ RCS Service
(Name: _____ ) (430)
(Mo Spending: $_____ ) (431)

Vendor: _____ (432)
Package Name: _____ (433)
Price: $_____ (434) (only if purchased)

_____ (435) (436)___ Internally Developed
(437)___ Public Domain Software Source: _____ (438)
(439)___ Commercial Software Package

Used on:
(440)___ Pers Computer
(441)___ Mini Computer
(442)___ IS Data Center
(443)___ RCS Service
(Name: _____) (444)
(Mo Spending:$_____) (445)

Vendor: _____ (446)
Package Name: _____ (447)
Price:$_____ (448) (only if purchased)

h. Are there any important new project management applications that you have added in the past year?

(1) _____ (449)

(2) _____ (450)

(3) _____ (451)

i. Are there any important new applications that you plan on adding in the next year?

Application

_____ (452) (453)___ Internally Developed
(454)___ Public Domain Software Source: _____ (455)
(456)___ Commercial Software Package

Used on:
(457)___ Pers Computer
(458)___ Mini Computer
(459)___ IS Data Center
(460)___ RCS Service
(Name: _____) (461)
(Mo Spending:$_____) (462)

Vendor: _____ (463)
Package Name: _____ (464)
Price:$_____ (465) (only if purchased)

(466) _____ (467)___ Internally Developed
(468)___ Public Domain Software Source: _____ (469)
(470)___ Commercial Software Package

Used on:
(471)___ Pers Computer
(472)___ Mini Computer
(473)___ IS Data Center
(474)___ RCS Service
(Name: _____) (475)
(Mo Spending:$_____) (476)

Vendor: _____ (477)
Package Name: _____ (478)
Price:$_____ (479) (only if purchased)

j. Please tell us what computers or computer services your firm purchased in the past year to support your project management. Also tell us how you see this purchasing pattern changing in the future.

| Category | $ Spent | Change fm Prior Yr | Change in Next 3 Yrs |
|---|---|---|---|
| Total Spending | $_____ (481) | _____% (488) | _____% (495) |
| Sci/Eng Software Packages | $_____ (482) | _____% (489) | _____% (496) |
| Single-user or Personal Computers ($<15,000) | $_____ (483) | _____% (490) | _____% (497) |
| Dept-owned Multi-user (15,000 < $ <300,000) | $_____ (484) | _____% (491) | _____% (498) |
| Corporate Data Center (IS machine) | $_____ (485) | _____% (492) | _____% (499) |
| Outside Remote Computer Service (RCS) Vendor | $_____ (486) | _____% (493) | _____% (500) |
| Other_____ (480) | $_____ (487) | _____% (494) | _____% (501) |

k. What are some of the important reasons for your changing usage? (502)

_____

_____

23. GRAPHICS/PLOTTING

a. What percent of your firm's spending for computers or computer services is in support of graphics/plotting? _____% (503)

b. How has your firm's workload in graphics/plotting changed in the past year? _____% (504)

c. How has that affected your sepending on computers or computer services? _____% (505)

d. How do you expect your workload in graphics/plotting change in the next 12 to 18 months? _____% (506)

e. How will that effect your spending on computers or computer services? _____% (507)

f. What is(are) the reason(s) for the change(s)? (508)

_____

_____

g. Would you name the several of the more important computer applications in your firm's graphics/plotting work:

Application

(509) _____ (510) ___ Internally Developed
(511) ___ Public Domain Software Source: _____ (512)
(513) ___ Commercial Software Package

Used on:
(514) ___ Pers Computer
(515) ___ Mini Computer
(516) ___ IS Data Center
(517) ___ RCS Service
(Name: _____) (518)
(Mo Spending:$_____) (519)

Vendor: _____ (520)
Package Name: _____ (521)
Price:$_____ (only if purchased)

_____ (522)
(523) ___ Internally Developed
(524) ___ Public Domain Software Source: _____ (525)
(526) ___ Commercial Software Package

Used on:
(527) ___ Pers Computer
(528) ___ Mini Computer
(529) ___ IS Data Center
(530) ___ RCS Service
(Name: _____) (531)
(Mo Spending:$_____) (532)

Vendor: _____ (533)
Package Name: _____ (534)
Price:$_____ (only if purchased) (535)

_____(536) (537)___ Internally Developed
(538)___ Public Domain Software Source:_____(539)
(540)___ Commercial Software Package

Used on:
(541)___ Pers Computer
(542)___ Mini Computer
(543)___ IS Data Center
(544)___ RCS Service
(Name:_____)(545)
(Mo Spending:$_____)(546)

Vendor:_____(547)
Package Name:_____(548)
Price:$_____(549) (only if purchased)

h. Are there any important new graphics/plotting applications that you have added in the past year?

(1)_____(550)

(2)_____(551)

(3)_____(552)

i. Are there any important new applications that you plan on adding in the next year?

Application

_____(553) (554)___ Internally Developed
(555)___ Public Domain Software Source:_____(556)
(557)___ Commercial Software Package

Used on:
(558)___ Pers Computer
(559)___ Mini Computer
(560)___ IS Data Center
(561)___ RCS Service
(Name:_____)(562)
(Mo Spending:$_____)(563)

Vendor:_____(564)
Package Name:_____(565)
Price:$_____(566) (only if purchased)

_____(567) (568)___ Internally Developed
(569)___ Public Domain Software Source:_____(570)
(571)___ Commercial Software Package

Used on:
(572)___ Pers Computer
(573)___ Mini Computer
(574)___ IS Data Center
(575)___ RCS Service
(Name:_____)(576)
(Mo Spending:$_____)(577)

Vendor:_____(578)
Package Name:_____(579)
Price:$_____(580) (only if purchased)

j. Please tell us what computers or computer services your firm purchased in the past year to support your graphics/plotting. Also tell us how you see this purchasing pattern changing in the future.

| Category | $ Spent | Change fm Prior Yr | Change in Next 3 Yrs |
|---|---|---|---|
| Total Spending | $_____ (582) | _____% (589) | _____% (596) |
| Sci/Eng Software Packages | $_____ (583) | _____% (590) | _____% (597) |
| Single-user or Personal Computers ($<15,000) | $_____ (584) | _____% (591) | _____% (598) |
| Dept-owned Multi-user (15,000 < $ <300,000) | $_____ (585) | _____% (592) | _____% (599) |
| Corporate Data Center (IS machine) | $_____ (586) | _____% (593) | _____% (600) |
| Outside Remote Computer Service (RCS) Vendor | $_____ (587) | _____% (594) | _____% (601) |
| Other_____ (581) | $_____ (588) | _____% (595) | _____% (602) |

k. What are some of the important reasons for your changing usage? (603)

_____

_____

24. OTHER ENG. DISCIPLINE

What is it? _____ (604)

a. What percent of your firm's spending for computers or computer services is in support of this other discipline? _____% (605)

b. How has your firm's workload in this other discipline changed in the past year? _____% (606)

c. How has that affected your sepending on computers or computer services? _____% (607)

d. How do you expect your workload in this other discipline change in the next 12 to 18 months? _____% (608)

e. How will that effect your spending on computers or computer services? _____% (609)

f. What is(are) the reason(s) for the change(s)? (610)

_____

_____

g. Would you name the several of the more important computer applications in your firm's this other discipline work:

Application

_____ (611)

(612) ___ Internally Developed
(613) ___ Public Domain Software Source: _____ (614)
(615) ___ Commercial Software Package

Used on:
(616) ___ Pers Computer
(617) ___ Mini Computer
(618) ___ IS Data Center
(619) ___ RCS Service
(Name: _____) (620)
(Mo Spending: $_____) (621)

Vendor: _____ (622)
Package Name: _____ (623)
Price: $_____ (624) (only if purchased)

_____ (625)

(626) ___ Internally Developed
(627) ___ Public Domain Software Source: _____ (628)
(629) ___ Commercial Software Package

Used on:
(630) ___ Pers Computer
(631) ___ Mini Computer
(632) ___ IS Data Center
(633) ___ RCS Service
(Name: _____) (634)
(Mo Spending: $_____) (635)

Vendor: _____ (636)
Package Name: _____ (637)
Price: $_____ (638) (only if purchased)

_____ (639) (640)___ Internally Developed
(641)___ Public Domain Software Source: _____ (642)
(643)___ Commercial Software Package

Used on:
(644)___ Pers Computer
(645)___ Mini Computer
(646)___ IS Data Center
(647)___ RCS Service
(Name: _____)(648)
(Mo Spending:$_____)(649)

Vendor: _____ (650)
Package Name: _____ (651)
Price:$_____ (652) (only if purchased)

h. Are there any important new this other discipline applications that you have added in the past year?

(1) _____ (653)

(2) _____ (654)

(3) _____ (655)

i. Are there any important new applications that you plan on adding in the next year?

Application

_____ (656) (657)___ Internally Developed
(658)___ Public Domain Software Source: _____ (659)
(660)___ Commercial Software Package

Used on:
(661)___ Pers Computer
(662)___ Mini Computer
(663)___ IS Data Center
(664)___ RCS Service
(Name: _____)(665)
(Mo Spending:$_____)(666)

Vendor: _____ (667)
Package Name: _____ (668)
Price:$_____ (669) (only if purchased)

_____ (670) (671)___ Internally Developed
(672)___ Public Domain Software Source: _____ (673)
(674)___ Commercial Software Package

Used on:
(675)___ Pers Computer
(676)___ Mini Computer
(677)___ IS Data Center
(678)___ RCS Service
(Name: _____)(679)
(Mo Spending:$_____)(680)

Vendor: _____ (681)
Package Name: _____ (682)
Price:$_____ (683) (only if purchased)

j. Please tell us what computers or computer services your firm purchased in the past year to support your this other discipline. Also tell us how you see this purchasing pattern changing in the future.

| Category | $ Spent | Change fm Prior Yr | Change in Next 3 Yrs |
|---|---|---|---|
| Total Spending | $_____ (685) | _____% (692) | _____% (699) |
| Sci/Eng Software Packages | $_____ (686) | _____% (693) | _____% (700) |
| Single-user or Personal Computers ($<15,000) | $_____ (687) | _____% (694) | _____% (701) |
| Dept-owned Multi-user (15,000 < $ <300,000) | $_____ (688) | _____% (695) | _____% (702) |
| Corporate Data Center (IS machine) | $_____ (689) | _____% (696) | _____% (703) |
| Outside Remote Computer Service (RCS) Vendor | $_____ (690) | _____% (697) | _____% (704) |
| Other_____ (684) | $_____ (691) | _____% (698) | _____% (705) |

k. What are some of the important reasons for your changing usage? (706)

_____

_____

(Thank the respondent for participating in our study. Verify address for Executive Summary.)

# APPENDIX B: VENDOR QUESTIONNAIRE

CONFIDENTIAL

INPUT VENDOR QUESTIONNAIRE

CATALOG NO: M E S 3 __.__.__.
S I C CODE: __.__.__.__.__.
SIZE CODE: __.__.
AREA CODE: __.__.__.
STUDY CODE: __.__.
DATES: __.__.__.__.__.__.
M M D D Y Y

STUDY TITLE: Opportunities for Eng/Sci Computer Services.

Type of Interview: ( X ) Vendor

---

Input Interviewer:_____ Date:_____

Respondent: _____ Co Type

Title: _____ ( ) RCS Vendor

Company: _____ ( ) Software Vendor

Address 1: _____ ( ) Hardware Mfg.

Address 2: _____ ( ) Other_____

City, State Zip:_____ _____

Phone num: _____

Company Information

| | |
|---|---|
| Company Revenue | $_____ |
| U S Information Services Revenue | $_____ |
| Processing Services Rev | $_____ |
| Batch | $_____ |
| RCS | $_____ |
| Software Products | $_____ |
| Professional Services | $_____ |
| Integrated (Turnkey) Systems | $_____ |

Comments:_____

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1. Could you contrast this market now (1983) with how it was 3 years ago?

2. What do you see for the future of this market 3 years from now (1987)?

3. I am going to list some Eng/Sci disciplines and some modes of delivery of services in that discipline. Please tell me, for each discipline whether you offer (1) Processing Services, (2) Professional Services (consulting), (3) Integrated Systems (Turnkey Systems), or (4) Software sales. For those disciplines in which you do offer services, please tell me the relative importance of that discipline to your firm. (1 is little importance - an afterthought, 5 is crucial - one of the cornerstones of the business.)

| Discipline | (1) | (2) | (3) | (4) | Rel Importance |
|---|---|---|---|---|---|
| Structural Eng | ____ | ____ | ____ | ____ | ____ |
| Civil Eng | ____ | ____ | ____ | ____ | ____ |
| Nuclear Eng | ____ | ____ | ____ | ____ | ____ |
| Project Management | ____ | ____ | ____ | ____ | ____ |
| Electrical/onic Eng | ____ | ____ | ____ | ____ | ____ |
| Aeronautical Eng | ____ | ____ | ____ | ____ | ____ |
| Statistics/Operations Res. | ____ | ____ | ____ | ____ | ____ |
| Chemical/Process Eng | ____ | ____ | ____ | ____ | ____ |
| Graphics/Plotting | ____ | ____ | ____ | ____ | ____ |
| Other_____ | ____ | ____ | ____ | ____ | ____ |
| Other_____ | ____ | ____ | ____ | ____ | ____ |

4. Could you give me an estimate of the monthly revenues for each discipline within each delivery mode that you offer?

| Discipline | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Structural Eng | $_____ | $_____ | $_____ | $_____ |
| Civil Eng | $_____ | $_____ | $_____ | $_____ |
| Nuclear Eng | $_____ | $_____ | $_____ | $_____ |
| Project Management | $_____ | $_____ | $_____ | $_____ |
| Electrical/onic Eng | $_____ | $_____ | $_____ | $_____ |
| Aeronautical Eng | $_____ | $_____ | $_____ | $_____ |
| Statistics/Operations Res. | $_____ | $_____ | $_____ | $_____ |
| Chemical/Process Eng | $_____ | $_____ | $_____ | $_____ |
| Graphics/Plotting | $_____ | $_____ | $_____ | $_____ |
| Other_____ | $_____ | $_____ | $_____ | $_____ |
| Other_____ | $_____ | $_____ | $_____ | $_____ |

5. Would you give me an estimate of your planned delivery modes within 18 months from now (Target date 1/1/85)?

| Discipline | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Structural Eng | _____ | _____ | _____ | _____ |
| Civil Eng | _____ | _____ | _____ | _____ |
| Nuclear Eng | _____ | _____ | _____ | _____ |
| Project Management | _____ | _____ | _____ | _____ |
| Electrical/onic Eng | _____ | _____ | _____ | _____ |
| Aeronautical Eng | _____ | _____ | _____ | _____ |
| Statistics/Operations Res. | _____ | _____ | _____ | _____ |
| Chemical/Process Eng | _____ | _____ | _____ | _____ |
| Graphics/Plotting | _____ | _____ | _____ | _____ |
| Other_____ | _____ | _____ | _____ | _____ |
| Other_____ | _____ | _____ | _____ | _____ |

6. Would you give me your forecast of the revenue growth (decrease) in each area in the next 18 months.

| Discipline | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Structural Eng | ____% | ____% | ____% | ____% |
| Civil Eng | ____% | ____% | ____% | ____% |
| Nuclear Eng | ____% | ____% | ____% | ____% |
| Project Management | ____% | ____% | ____% | ____% |
| Electrical/onic Eng | ____% | ____% | ____% | ____% |
| Aeronautical Eng | ____% | ____% | ____% | ____% |
| Statistics/Operations Res. | ____% | ____% | ____% | ____% |
| Chemical/Process Eng | ____% | ____% | ____% | ____% |
| Graphics/Plotting | ____% | ____% | ____% | ____% |
| Other_____ | ____% | ____% | ____% | ____% |
| Other_____ | ____% | ____% | ____% | ____% |

7. What are your five largest Eng/Sci applications or packages (in revenues)?

| | Application | Software Vendor | Discipline | Mo Revenues | Delivery Mode |
|---|---|---|---|---|---|
| (1) | _____ | _____ | _____ | $_____ | _____ |
| (2) | _____ | _____ | _____ | $_____ | _____ |
| (3) | _____ | _____ | _____ | $_____ | _____ |
| (4) | _____ | _____ | _____ | $_____ | _____ |
| (5) | _____ | _____ | _____ | $_____ | _____ |

8. What are some of the key elements in your overall strategy to serve the Eng/Sci market? What are some of the impediments or bottlenecks that you see?

9. Are there any market strategies, activities, or campaigns that have been particularly effective for you in the Eng/Sci market? What are they? Can you give me an Example?

10. Is there a strategy or campaign that was particularly unsucessful? What was it? Can you give me an example?

11. Who are some of the most successful computer service companys serving the Engineering and Scientific marketplace? Why?

12. I am going to list some reasons for your customers to use a RCS vendor for their Eng/Sci processing (as opposed to using an in-house facility). Please rate these reasons to go outside on how important you feel they are to your customers. (1 is not important at all, 5 is critical importance):

a. Availability of proprietary Eng/Sci application software _____

b. Availability of applications support or training from RCS vendor _____

c. Lower cost than in-house facilities _____

d. Availability of supercomputer (Cray, Cyber, etc.)

e. Availability of extreme accuracy on RCS machine (60 bit word) ____

f. Short-term project cannot justify in-house computer ____

g. Lack of any in-house alternative ____

h. Availability of funds to procure in-house computer ____

i. Better price/performance on RCS ____

13. I am going to list several reasons that customers use to choose among RCS vendors. Please give me your opinion of the relative importance of these reasons to your customers. (1 means not important at all; 5 is critical importance.)

a.____ Existing business relationship (Open PO, vendor is on TSP or GSA schedule, etc.)

b.____ Relative quality of support and/or training provided by RCS Vendor.

c.____ Price/performance of RCS Vendor.

d.____ Availability of proprietary software (not available elsewhere).

e.____ Need for particular set of hardware facilities ( i. e. CPU brand, plotter, peripherals, TP Network, etc.)

f.____ Ability to purchase RCS applications software for subsequent in-house use.

14. In general terms, how would you rate the profitability of your business in the Engineering/Scientific area for 1982:

____ Not Profitable

____ 0-5% Profit Margin

____ 5-15% Profit Margin

____ 15-25% Profit Margin

____ More than 25% Profits

15. Verify the respondent's name and address for Executive Summary

16. Thank You Very Much.